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THE CONSTRUCTION OF THE NEW FOREST PARK BRIDGE FOR THE WABASH R. R. AT ST. LOUIS, MO.

The accompanying drawings give some of the structural details and the methods of construction adopted in building the new Wabash R. R. bridge crossing the main drive at the entrance to Forest Park at St. Louis, Mo. The bridge formerly located at this point was built about 20 years ago, and had a span of only 40 ft. Because of the narrow roadway and the increasing vehicle and pedestrian traffic, considerable trouble was experienced from congestion under the crossing, and some months ago the city authorities requested the railway company to lengthen the bridge to a span of 70 ft., and to make the new structure fitting to its location by proper aesthetic treatment. In consideration of the extra cost to the railway company of constructing an ornamental structure, the city agreed to contribute $15,000 toward the cost of the bridge.

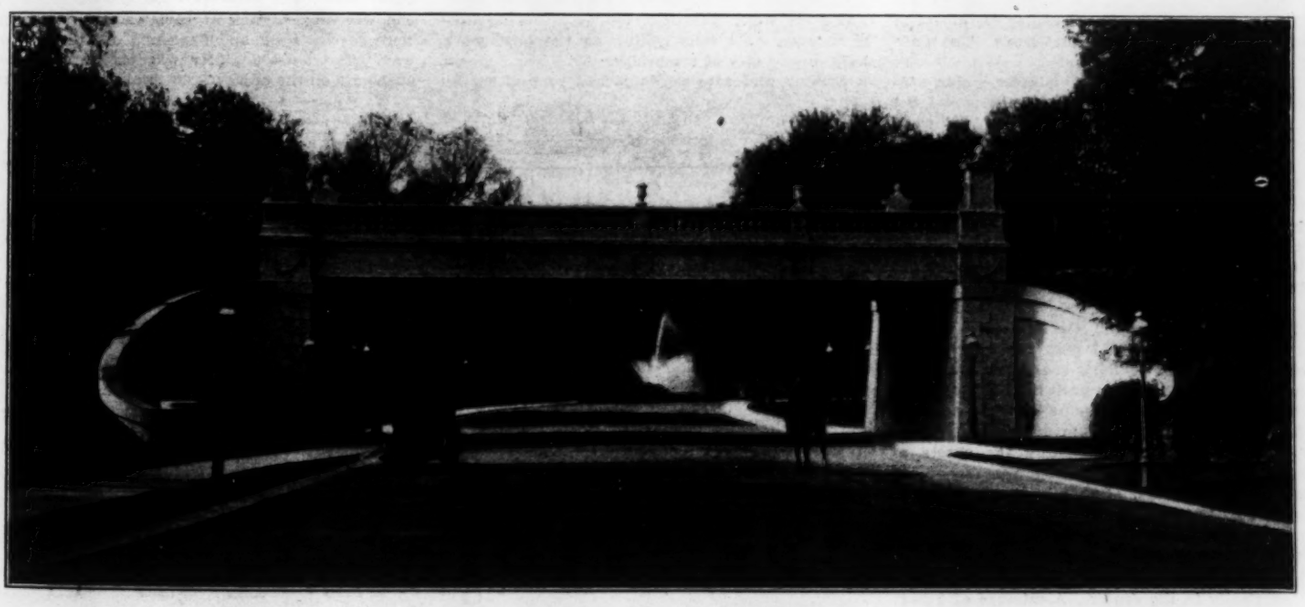
The design of the new bridge was undertaken by Mr. A. O. Cunningham, M. Am. Soc. C. E., Bridge Engineer of the Wabash R. R. The first thought was to design an arch bridge, but this was found to be impracticable because of the limited head room. There remained then only the use of through girders treated in such a manner as to make a sightly structure. As these girders were to be 80 ft. long, it was necessary to make them at least 8 ft. deep. The solution of the problem that was finally settled upon was to construct a through plate girder bridge, and to mask or conceal the steel structure by means of an ornamental facade of concrete. The reasons that led to this decision were as follows:

The cost of the bridge was limited to $25,000, and while this seems at first sight a large amount for such a small structure the work involved really necessitated strict economy to keep within the limit set. The new abutments had to be constructed behind the old abutments and the necessary excavation and masonry work had to be done without disturbing the traffic, which amounted to some 300 trains a day. To save expense and facilitate the work it was, therefore, decided to use reinforced concrete for the abutments and to make them hollow. The use of concrete for the abutments naturally determined the use of the same material for masking the steel work and for such ornamentation as might be decided upon.

The bridge as designed and constructed is shown by our front page picture. Except from underneath and for such glimpses of the steel girders as may be caught through the railing balusters, the bridge has the appearance of a concrete girder structure carried on concrete abutments. The steel structure proper consists of three 80-ft. plate girders set 15 ft. apart c. to c. and provided with a floor of 15-in. I-beams set 18 ins. apart and carrying a reinforced concrete floor slab. The only other metal work are the brackets attached to the outside girders to support the concrete facade and railing. Practically the only unusual features of the structure are, therefore, the reinforced concrete hollow abutments, the solid floor and the masking railing or facade. These are described in order in the following paragraphs.

ABUTMENTS.—The construction of the abutments is clearly shown by the drawings of Fig. 1. As will be seen, both the abutment wall proper and the curved wing walls are retaining walls with counterforts, and the concrete is elaborately reinforced by bars. The concrete used for the abutments was a 1:2:5 Portland cement, stone mixture, and the reinforcing bars were all of the Johnson corrugated type. It may be noted here that this form of abutment was first used by Mr. Cunningham at Monticello, Ill., as described in our issue of July 21, 1904.

The forms used in constructing the abutments call for brief description only. The only part that called for particular care was the face lagging. For the straight faces 2 × 6-in. vertical studding was set up and the lagging boards of ⅞-in. dressed stuff were nailed to it horizontally.



BRIDGE CARRYING THE WABASH R. R. OVER THE MAIN DRIVE ENTRANCE TO FOREST PARK, ST. LOUIS, MO.
(This is a through plate girder bridge with reinforced concrete abutments and an ornamental reinforced concrete facade and railing to mask the girders.)

The drawings of Fig. 2 show the construction quite clearly. For the curved wing walls horizontal girts cut to the radius of the curve were set between the studs and the lagging boards were set vertically and nailed to the girts. All the lagging was tongued and grooved material.

SOLID FLOORS.—The construction of the solid floor is clearly shown by the drawings of Fig. 3. I-beams spaced 18 ins. apart carry on their top flanges a concrete slab reinforced by a double layer of longitudinal bars and a single layer of transverse bars. The dimensions of the slab and the arrangement of the reinforcement are shown clearly by the drawings. As will be seen, the bal-

last is placed directly on the concrete slab and the regular track construction thus continued across the bridge.

The method of constructing the reinforced floor slab is shown by the drawings of Fig. 4. To form the bottom of the slab a centering was built between each pair of I-beams with its top flush with the top flanges. The reinforcing bars were then

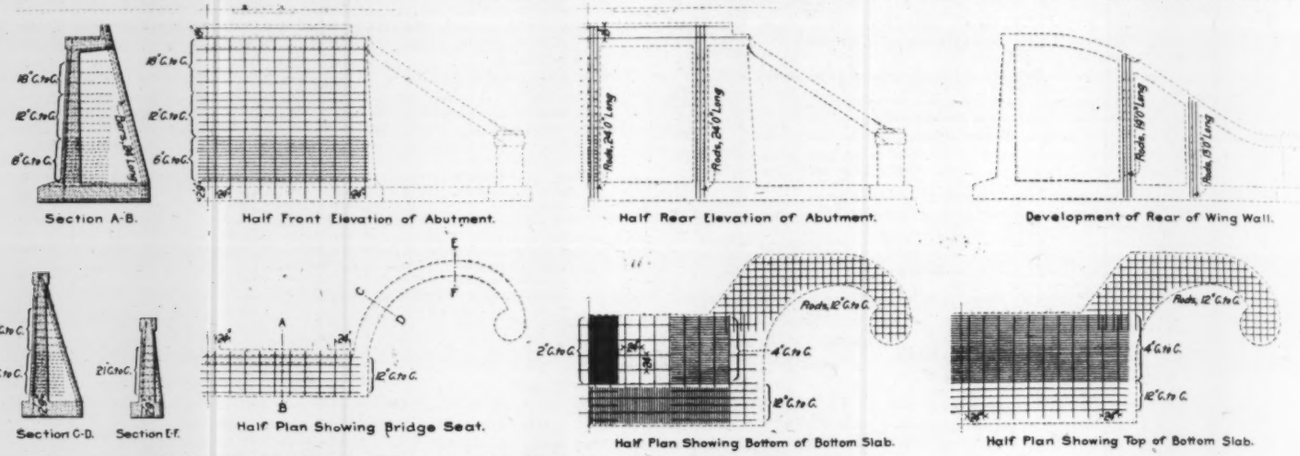

Section A-B.
Half Front Elevation of Abutment.
Half Rear Elevation of Abutment.
Development of Rear of Wing Wall.
Section C-D.
Section E-F.
Half Plan Showing Bridge Seat.
Half Plan Showing Bottom of Bottom Slab.
Half Plan Showing Top of Bottom Slab.

FIG. 1. DETAILS OF REINFORCED CONCRETE ABUTMENTS FOR FOREST PARK BRIDGE.

placed and held in position by notched boards set transversely across the bridge. The concrete was deposited in a single layer on the centering and enveloping the bars.

FACADE.—The facade and railing designed to mask the girders was constructed as shown by Fig. 5. The solid facade proper was constructed by means of the forms shown in Fig. 6. The ceiling slab was first built and allowed to set and then the forms were erected for the frieze and coping. After these had been concreted the forms were continued upward as shown for the base of the railing. Above this point the several parts of the railing were cast in sections and set in place like cut stone. The mode of procedure was as follows:

The balusters were cast in plaster molds. To make these molds a box square in plan and the height of the baluster was constructed of wood and cut vertically into three sections. The inside lateral dimensions of this box were made 6 ins. greater than the largest dimension of the baluster. A full size wooden pattern of the baluster was set up and the three sections of the box set around it. Sheets of thin galvanized metal, with their inner edges cut to conform to the curves of the baluster, were inserted in the joints of the assembled box so as to divide the vacant space between the pattern and the box into vertical sections. A mixture of 1 part Portland cement and 1 part plaster of Paris made wet was then poured around the pattern until the box was filled. When this mixture had become hard the box was taken down, leaving a plaster and cement casing separated into three sections by the sheets of galvanized metal. This casing was separated from the pattern and given a coat of shellac on the inside. Four or five molds of this description were cast and used for molding the concrete balusters proper. To cast a baluster the sections were assembled and a ½-in. corrugated bar was set vertically in the center. A mixture of 1 part Portland cement and 3 parts sand was then poured into the mold and allowed to harden. The molds for the urns on the railing posts and for the balls on the end posts were made in exactly the same manner as the baluster molds.

The construction of the railing posts is shown by the drawings of Fig. 7. Referring first to the end posts, it will be seen from the drawings that they were molded in place in seven sections, marked A, B, C, D, E, F and G. The construction of the mold for each section is shown by the corresponding lettered detail. The intermediate posts were not molded in place but were built up of the separately cast pieces I, K and H.

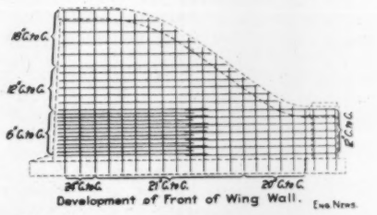
PROGRESS OF WORK AND ERECTION.—Plans were prepared by Mr. Cunningham and approved by Mr. W. S. Newhall on March 14, 1903. These plans were accepted by the Board Public Improvements on March 25, but as the arrangements for payments by the city were not completed, the work of commencing the bridge was delayed until about April 20.

The masonry construction was let to the Geisel Construction Co., of St. Louis, and the fabricating of the steel work to the American Bridge Co. The railway company erected the steel work. There were about 2,000 cu. yds. of earth removed from back of the old abutments, and the old abutments themselves contained about 580 cu. yds. of rock. As this material could not be taken away by work trains on account of traffic, it was necessary to cart it away and deposit it outside the park limits.

On account of the number of trains and the fact that the floor of the bridge was made of a concrete-steel slab, resting on steel I-beams, it was decided to erect the bridge on one side of the present structure. This was done on false work. The steel work was unloaded by wrecking derricks upon steel rails resting on the false work built on one side of the bridge. This was done on a Sunday and afterwards jacked to position by the bridge gang and riveted together. The concrete floor was put in and allowed to dry out for two weeks. The ornamental part was not put on until the new girders were in place.

Because of the shuttle trains, it was impossible to take out the old bridge and put the new one in place on a week day, and as they did not run on Sundays, it was decided to do this work on one of these days. The old structure consisted of three main girders with floor beams and stringers for carrying two tracks. The work of replacing the old structure with the new was done in the following way:

When all the in-bound trains had crossed the bridge the work of taking up the rails and ties on



the in-bound track was commenced at 9 o'clock in the morning. Then the stringers and floor beams under this track were cut loose and by means of one wrecking derrick at each end of the bridge were carried back and deposited on the right of way. The outside girder was placed upon two push cars on the adjacent track and carried out of the way. The new bridge was then pulled half way in place with previously arranged triple blocks and 1½-in. rope by locomotives attached to the derricks. The triple blocks were fastened to a 12 × 12-in. vertical timber with one end buried in the ground and the other end resting against the coping of the abutment and projecting above

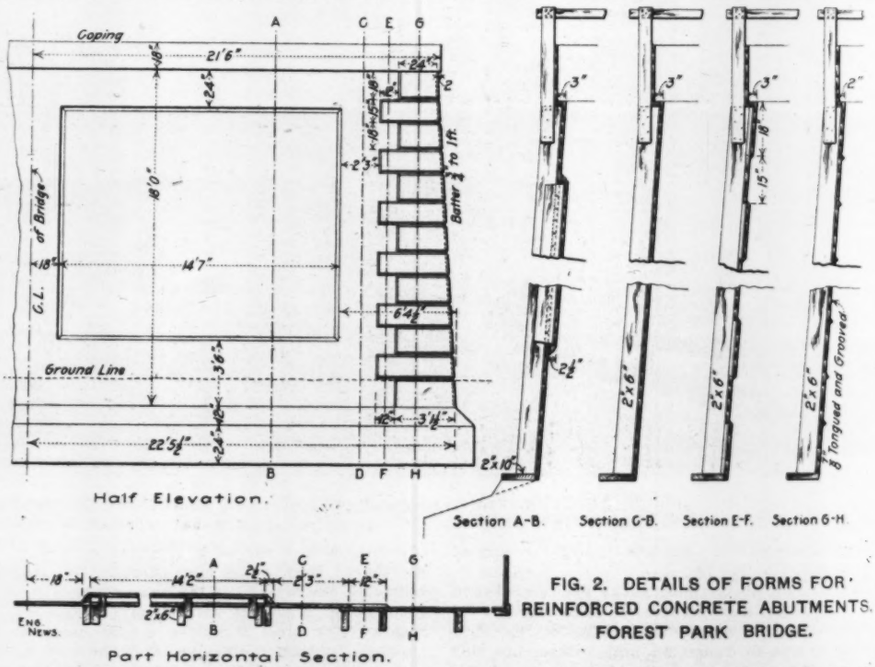


FIG. 2. DETAILS OF FORMS FOR REINFORCED CONCRETE ABUTMENTS. FOREST PARK BRIDGE.

sat... about 2 ft. To this projection one triple blo... was attached. It was necessary to do the wo... in this way, as the city would allow no obstr... on in the roadway, so that no false work co... be placed under the bridge. When the new bri... was half way in place the track was laid o... that part, the ballast and ties having previ-

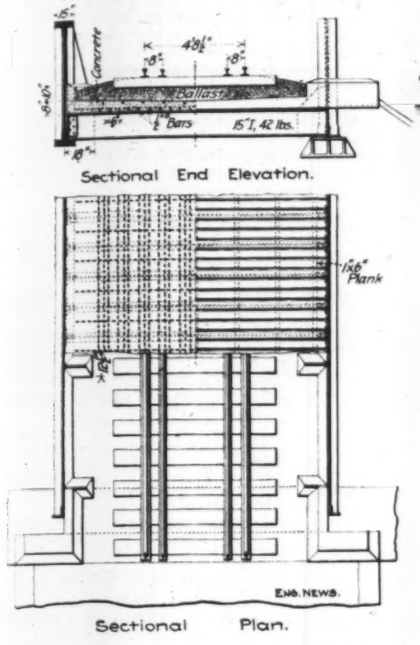


Fig. 3. Details of Solid Floor Construction, Forest Park Bridge.

(This is a standard construction of the Wabash R. R. for solid floors for through girder bridges.)

ously been placed thereon. By doing the work in this way there was always one track crossing the bridge, thus allowing all the regular trains to be handled on this one track. As soon as the inbound track was connected up over the new half of the bridge the other half of the old bridge was disconnected in a similar way and when removed the track over the new portion was then disconnected. The bridge was then pulled into its proper position and by 6 o'clock both tracks were connected.

The total weight of the structure while being pulled in place was 230 tons. This included the concrete floor and the ballast and ties. As soon as the bridge was in place the ornamental part was built on brackets attached to the girders at intervals of about 6 ft. The bridge as shown in the photograph is not quite complete, from the fact that ornamental bronzed lamp posts are to be placed at the foot of the abutments and further bronze ornaments are to be placed in the sides of the newel posts at the ends of the bridge.

COST OF ORNAMENTAL WORK.—The cost of the ornamental concrete facade to the railway company is shown by the following figures:

Balusters, 60 cts. per piece.
Hand rail, 40 cts. per lin. ft.
Railing base, 45 cts. per lin. ft.
Frieze and coping, $2 per lin. ft.
Ceiling, 25 cts. per sq. ft.
Six intermediate posts with urns, $12 each.
Four newel posts, $75 each (at ends of bridge).

The cost therefore of the ornamental part of the work other than the abutments was about $1,000.

For the information from which this description has been prepared we are indebted to Mr. A. O. Cunningham, Engineer of Bridges, Wabash R. R., St. Louis, Mo.

TWO NEW TIMBER PRESERVATION PROCESSES AT THE ST. LOUIS EXHIBITION.

One department of the U. S. Government exhibits at the St. Louis Exhibition is the plant installed by the Bureau of Forestry (Department of Agriculture) for the treatment of timber by preservative processes and the determination of the effect of such treatment upon the strength of the timber. The preserving plant consists of a retort or impregnating cylinder capable of standing a pressure of 600 lbs. per sq. in., together with the necessary equipment of vacuum and pressure pumps, tanks, etc. This plant has been loaned by the Allis-Chalmers Co. and the Ayer & Lord Tie Co. The equipment of the testing plant consists of a large impact machine and a smaller

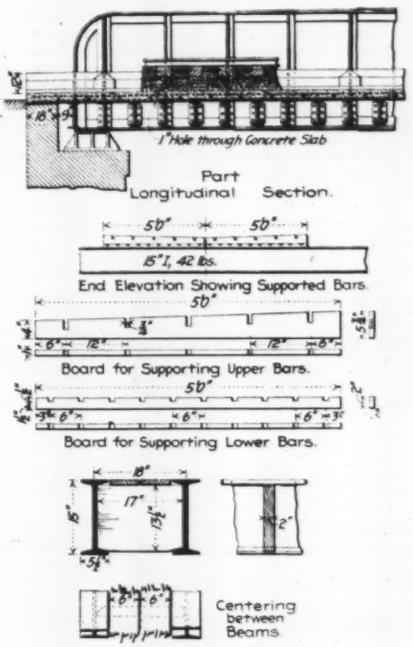

1" Hole through Concrete Slab
Part Longitudinal Section.
15"I, 42 lbs.
End Elevation Showing Supported Bars.
Board for Supporting Upper Bars.
Board for Supporting Lower Bars.
Centering between Beams.

Fig. 4. Centers and Templates for Constructing Solid Floors of Reinforced Concrete, Wabash R. R.

30,000-lb. Olsen testing machine, with motor-driven saw and planer for shaping the test timbers and test pieces.

We are informed that so far the tests which have been conducted at this plant have been largely of a scientific character, while tests have also been made to determine various points re-

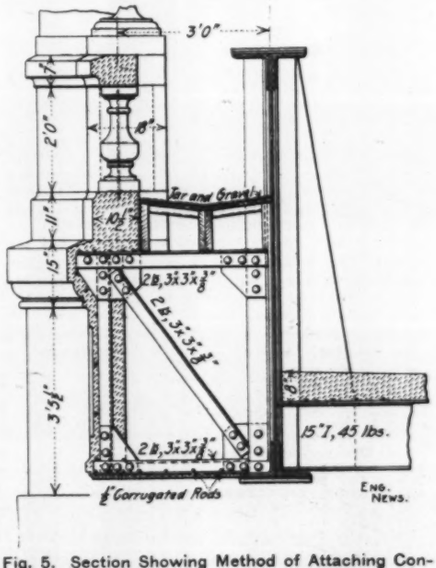


Fig. 5. Section Showing Method of Attaching Concrete Facade to Plate Girders.

lating to the penetration of zinc-chloride and creosote into green and seasoned loblolly pine and red oak.

THE RUEPING PROCESS.

The plant has also been used by the representatives of the Rueping process to make tests under this process, with the cooperation of several engineers, but the Bureau of Forestry had nothing to do with these tests.

In the Rueping process, which is a German invention, the principal object is to make commercially practicable the treatment with preservative materials which are of the highest efficiency, but which have only been used to a limited extent on account of their high price. It is therefore specially adapted to the use of creosote in this country, but can be used also with chemical solutions, as it requires less of the fluid, and can, therefore, use a more highly concentrated solution without increasing the cost of treatment over that by other processes. This has the further advantage that less water is forced into the timber to carry the preservative, and the water thus forced in must in any case be largely removed by evaporation before the timber is fit to be used.

The plant consists of impregnating cylinders strong enough to carry pressures of 100 to 225 lbs., a tar-oil or creosote tank for pressures of 75 to 120 lbs., an air compressor which may also serve as a vacuum pump, a steam pump, and a boiler. In other processes for creosoting, the wood cells are filled with the creosote, but with the Rueping process it is intended that only the walls of the cells should be saturated with the creosote. As to the different stages of the process, we quote the following from a pamphlet issued by C. Lembcke & Co., 128 Water St., New York, who are the representatives of Huelsberg & Co., of Charlottenburg, Germany, the owners of the patents taken out by Mr. Rueping:

In the new Rueping process the seasoned wood is subjected for about half an hour to one hour to an air pressure of 60 to 65 lbs., so that all cells must be filled with compressed air. This is the principal difference between the old and the new method: with the former the air is removed from the wood cells by a vacuum, whereas with the latter the wood is filled with compressed air.

Without reducing the pressure in the impregnating cylinder, the warmed impregnating fluid is then forced from the tar reservoir into the impregnating cylinder by means of a somewhat higher pressure, say, of about 65 to 75 lbs. In proportion to the quantity of tar entering the impregnating cylinder, air is permitted to escape through a valve, in order to make room for an equivalent volume of impregnating fluid. At the same time, it must be borne in mind to allow only such a quantity of aid to escape as cannot impair the maintenance of the pressure of 60 to 65 lbs. When the wood in the cylinder is completely covered with the impregnating fluid, the pressure, according to the dimensions and qualities of the material, is to be increased to 105 to 225 lbs. Under this increased pressure the impregnating fluid will penetrate into the cells of the wood.

It might appear that through the forcible advance of the fluid the compressed air contained in the wood would be forced to the interior and there form a kind of cushion or piston which would render an impregnation of this sort impossible. But owing to the high pressure, the tar-oil, in consequence of the capillary action of wood and its adhesive properties, moves along the cell walls into the innermost parts of the wood, soaking them entirely, by which the compressed air contained in the cells will be still more compressed and at the same time

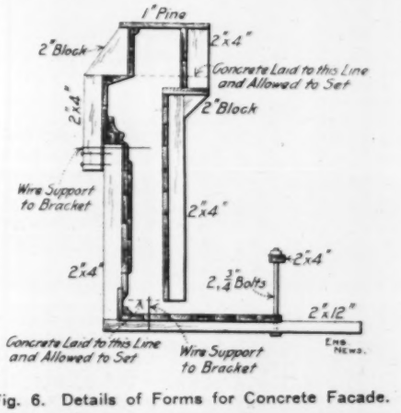


Fig. 6. Details of Forms for Concrete Facade.

entirely kept in suspension and inclosed by the advancing tar-oil.

When the material is sufficiently impregnated the pressure with great energy through its expansion, will force as much of the impregnating fluid out of the wood, as does not adhere to the cell walls, and this surplus is thus made to flow back into the creosote tank. This is the distinctive feature of the Rueping process.

Accordingly no more fluid can remain in the wood than is necessary for impregnating, coating or saturating the cell walls, etc., and this is the only important object in

view for the preservation of wood. In each case the pressure can be regulated in such a way that only a minimum quantity of fluid (or larger quantities, as required) remain in the cells of the impregnated wood. The oozing of the superfluous tar-oil may be increased and accelerated by exposing the impregnated wood to a vacuum for some time. By this means a further quantity of from 5 to 10% of the impregnating fluid left in the wood may be regained.

THE GIUSSANI PROCESS.

Near the plant of the Bureau of Forestry is a plant for preserving and fireproofing timber by treatment with the Guissani process. This plant is operated as an independent exhibit by the Consolidated Cross-Tie Co., 27 William St., New York, which controls the patents for all countries except Italy. The process is the invention of Mr. Tomasso Giussani, of Italy, who has been awarded the Brambilla prize of the Royal Institute of Science and Letters of Lombardy. We are informed that it has been in use in Italy for about three years, and that all railway ties and telegraph poles now used in that country are preserved by this process. The process applies to the method of treatment alone, and may be used in connection with any of the preservative materials or chemicals now in use. One of its special features is the low cost of the plant, as it requires no pressure cylinders, vacuum and pressure pumps, etc.; in fact, the cost is said to be but 20% of the cost of a plant operated in the usual way. The process is described as follows in a pamphlet issued by the company:

The method of impregnating railway ties consists of submitting the tie to a bath of anthracene and pitch or heavy oil of coal tar (or creosote oil) heated to about 285° F. This oil having a high boiling point, of (say) 400° F., shows no signs of ebullition when submitted to this degree of heat. Immediately upon the introduction of the ties into this hot oil, ebullition takes place, due to the fact that water boils at 212° F., and steam and moisture pass off, showing conclusively that some of the constituents of the wood are passing away, which, upon examination, prove to be sap, gum, etc. After a period varying from 1 to 4 hours, according to the condition and character of the wood, this ebullition ceases, showing that the sap, gums and moisture have completely passed off. In other words, the cells of the wood heretofore filled with sap, etc., have now been emptied and are in a state of partial vacuum, containing some steam.

The ties are now transported mechanically into another open tank containing cold creosote oil, lighter than in the first bath. They remain in this bath for from 3 to 5 minutes. As a result of the sudden drop in temperature, an internal gaseous contraction takes place, thereby absorbing the tar-oil. As the largest cells of the tie are on the outside, these naturally fill first, and as the tie remains in the creosote for so short a time, it is these outer cells that are first filled.

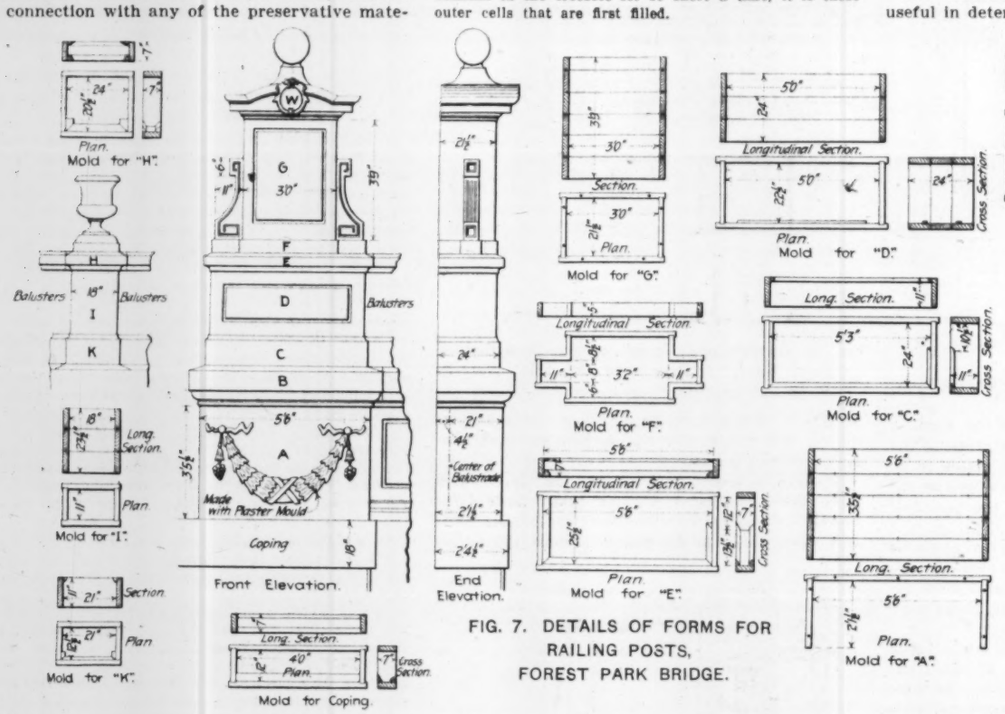


FIG. 7. DETAILS OF FORMS FOR RAILING POSTS, FOREST PARK BRIDGE.

Again, the tie is mechanically transported into a third bath consisting of cold chloride of zinc, and remains here for 2 or 3 hours, according to the amount of chloride of zinc desired to be injected into a given piece. Here the interior cells of the wood become filled with the chloride of zinc, as the contraction continues, and the vacuum in the interior cells still exists until the the bath have attained the same temperature.

The result of this combination treatment is t chloride of zinc is now in the center of the t e rounded by a stratum of creosote which prev possibility of the zinc salts leaching out, wh always been the one objection to the use of zinc as a preservative.

While it will be seen, however, from the f description, that it is possible and commerciall ticable to use a cheap preservative in this system not confined to a combination treatment, but any chemical desired in the cold bath; such as c sulphate of copper, tannin, in fact, any of the pr tives now in use. One of the greatest advantages process over the existing methods of preservation, the fact that the preserving fluids are applied equa each piece of wood treated, because the pieces ent baths simultaneously, and, further, the amount of servative to be applied to each piece of wood c accurately controlled, and the amount required inject

TABLES FOR COMPUTING COMPOUND DUPLEX ST M PUMPS.

By C. J. Mitchell.*

The five tables accompanying this article e useful in determining the principal proportion of compound duplex steam pumps. Table V. is printed in a number of catalogues, but is not generally available, for which reason it has been included. Table IV. the writer has seen printed in part; but the others are new, as far as known. The data for Tables I. and II. are taken from "Pumping Machinery," by Wm. M. Barr, and 15 per cent. loss is allowed in the steam end and 33⅓ per cent. in the water end.

The following example will illustrate the method of using these tables. It is desired to raise 2,000,000 gallons a day against a head of 150 ft. The steam pressure being 80 lbs., and the piston speed 125 ft. per minute, what cylinder proportions should be adopted?

Table V. shows that 2,000,000 gallons in 24 hrs. is equivalent to 1,390 gallons per minute. The pump being duplex, each plunger delivers 695 gallons at 100 ft. per minute piston speed. The given

*Beloit, Wis.

TABLE I.—Piston-Rod Pressures, Horsepowers, and Working Water Loads for Compound Direct-Acting Steam Pumps.

Non-condensing; 2 lbs. back pressure.

	Diameters of Steam Cylinders in inches.														
	6 and 10			8 and 12			8 and 14			9 and 14			10 and 16		
Gage press.	Press. lbs. on piston rod.	Steam H.P. 100 ft.	Working water load.	Press. lbs. on piston rod.	Steam H.P. 100 ft.	Working water load.	Press lbs. on piston rod.	Steam H.P. 100 ft.	Working water load.	Press. lbs. on piston rod.	Steam H.P. 100 ft.	Working water load.	Press. lbs. on piston rod.	Steam H.P. 100 ft.	Working water load.
Lbs.	Lbs.		Lbs.	Lbs.		Lbs.	Lbs.		Lbs.	Lbs.		Lbs.	Lbs.		Lbs.
60	2,280	6.9	1,520	3,620	11.0	2,410	3,680	11.3	2,440	4,680	14.2	3,120	5,850	17.7	3,890
65	2,550	7.7	1,700	3,960	12.0	2,630	4,050	12.3	2,700	5,160	15.6	3,440	6,440	19.6	4,300
70	2,760	8.3	1,830	4,320	13.1	2,870	4,450	13.4	2,980	5,620	17.0	3,740	6,950	21.1	4,630
75	2,960	9.0	1,970	4,660	14.1	3,090	4,800	14.6	3,230	6,100	18.5	4,060	7,570	22.8	5,020
80	3,190	9.7	2,130	5,020	15.3	3,350	5,280	15.8	3,500	6,570	19.9	4,370	8,170	24.9	5,440
85	3,430	10.4	2,280	5,360	16 3	3 570	5,620	17.1	3.750	7,030	21.4	4,680	8,760	26.5	5,840
90	3,650	11.2	2,430	5,720	17.4	3,800	5,940	18.2	3,950	7,490	22.7	4,980	9,350	28.4	6,240
95	3,850	11.7	2,570	6,060	18.4	4,040	6,320	19.3	4,210	7,950	24.1	5,290	9,980	30.2	6 650
100	4,100	12.4	2,730	6,400	19.4	4,250	6,800	20.5	4,530	8,390	25.4	5,590	10,500	31.9	6,990
110	4,560	13.8	3,030	7,150	21.6	4,750	7,600	23.0	5.060	9,160	27.6	6.100	11,700	35.4	7,790
120	5,020	15.4	3,350	7,840	23.7	5,200	8,360	25.4	5,560	9,850	29.8	6 500	12,900	39.2	8,590

	10 and 16			12 and 18			14 and 20			10 and 16		
60	5,850	17.7	3,890	8 150	24.6	5,430	10,000	30.3	6,670	14,500	43.9	9,650
65	6,440	19.6	4,300	8 900	27.0	5,930	10,950	33.0	7,300	15,800	47.8	10,500
70	6,950	21.1	4,630	9,700	29.4	6,450	11,950	36.1	7,950	17,200	52.0	11.450
75	7,570	22.8	5,020	10,500	31.9	6,990	12,900	39.1	8,630	18,700	56.4	12,450
80	8,170	24.9	5,440	11,300	34.3	7,520	13,900	42.2	9,300	20,100	61.0	13,350
85	8,760	26.5	5,840	12,100	36.6	8,050	14,850	45.1	9,901	21,500	65.1	14,320
90	9,350	28.4	6,240	12,900	39.1	8,580	15,850	48.0	10,500	22,900	69.2	15,250
95	9,980	30.2	6 650	13.650	41.4	9,090	16,800	50.9	11,100	24,300	73.8	16 180
100	10,500	31.9	6,990	14.450	43.8	9.650	17,750	53.8	11 850	25,600	77.5	17,150
110	11,700	35.4	7,790	16.050	48.8	10,700	19,850	60.2	13 200	28,500	86.2	19.000
120	12,900	39.2	8,590	17,600	53.2	11,700	21,950	66.3	14,600	31,200	94.2	20,400

TABLE II.—Piston-Rod Pressures. Horsepowers, and Working Water Loads for Compound Direct-Acting Steam Pumps.

Condensing; 11.5 lbs. vacuum.

	Diameters of Steam Cylinders in inches.														
	8 and 16			10 and 18			10 and 20			12 and 20			14 and 24		
Gage press.	Press. lbs. on piston rod.	Steam H.P. 100 ft.	Working water load.	Press. lbs. on piston rod.	Steam H.P. 100 ft.	Working water load.	Press. lbs. on piston rod.	Steam H.P. 100 ft.	Working water load.	Press. lbs. on piston rod.	Steam H.P. 100 ft.	Working water load.	Press. lbs. on piston rod.	Steam H.P. 100 ft.	Working water load.
Lbs.	Lbs.		Lbs.	Lbs.		Lbs.	Lbs.		Lbs.	Lbs.		Lbs.	Lbs.		Lbs.
60	5,380	16.4	3,560	8,550	25.9	5,690	8,420	25.5	5,610	12,750	38.6	8,480	16,800	50.9	11,180
65	5,750	17.4	3,830	9,200	27.9	6,130	9,020	27.4	6,010	13,700	41.5	9,150	17,950	54.4	11,950
70	6,190	18.6	4,100	9,800	29.7	6.530	9,670	29.3	6,410	14,600	44.2	9,720	19,200	58.1	12,790
75	6 550	19.8	4,360	10,400	31.5	6,940	10,350	31.1	6,820	15 500	47.0	10,310	20,450	61.8	13,580
80	6,940	21.0	4,620	11,050	33.5	7,350	10,850	32.9	7,220	16,400	49.6	10,910	21,460	65.0	14,390
85	7,350	22.3	4,890	11 650	35.3	7,750	11,500	34.9	7,650	17,300	52.4	11,510	22,650	68.6	15,100
90	7,750	23.5	5,160	12,250	37.5	8,150	12,150	36.8	8,070	18,200	55.1	12,110	24,000	72.6	15,980
95	8,150	24.7	5,430	12 900	39.1	8,540	12,750	38.6	8,470	19,150	58.0	12,740	25,200	76.3	16,780
100	8,550	25.9	5,690	13,500	40.9	8,940	13,350	40.5	8,880	20,050	60.7	13,350	26,400	80.0	17,600
110	9,350	28.3	6,220	14,750	44.5	9,820	14,650	44.3	9.750	21,850	66.2	14,550	28,800	87.2	19,200
120	10,150	30.6	6,750	16,000	48.5	10,650	15,850	48.0	10,550	24,000	72.6	16,000	31,200	94.5	20,780

	14 and 24			14 and 26			16 and 30			18 and 36		
60	16,800	50.9	11,180	16,650	50.4	11,090	22,150	67.1	14,750	27,200	82.4	18 100
65	17,950	54.4	11,950	17,800	54.2	11,900	23,700	71.8	15,780	29,100	88.1	19,450
70	19 200	58.1	12,790	19,050	57.7	12,690	25,300	76.6	16,850	31,200	94.5	20,750
75	20,450	61.8	13,580	20,250	61.3	13,490	26,900	81.5	17,900	33,200	100.6	22,100
80	21,600	65.4	14,390	21,450	65.0	14,290	28,500	86.2	18,950	35,200	106.6	23,450
85	22,800	69.0	15,180	22,650	68.6	15,100	30,200	91.4	20,100	37,200	112.8	24,750
90	24,000	72.6	15,980	23,900	72.4	15,910	31,800	96.1	21,150	39 200	118.8	26,100
95	25 200	76.3	16,780	25,100	76.0	16,710	33,400	101.1	22 210	41 200	124.9	27,400
100	26,400	80.0	17,600	26,300	79.6	17,510	35,000	106.0	23,300	43,200	131.0	28,700
110	28,800	87.2	19,200	28,700	86.9	19,110	38,200	115.7	25,450	47 400	148.5	31,450
120	31,200	94.5	20,780	31,100	94.2	20,700	41,400	125.5	27,600	51,300	155.5	34,200

TABLE III.—Working Water Load for Compound Direct-Acting Steam Pumps Taking High-Pressure Steam in Both Cylinders, Full Stroke.

Non-Condensing; 5 lbs. back pressure.

	Diameters of Compound Cylinders in inches.							
	and 10	8 and 12	8 and 14	8 and 16	9 and 14	10 and 16	10 and 18	10 and 20
	Working water load.	Working water load.	Working water load.	Working water load.	Working water load.	Working water load.	Working water load.	Working water load.
	2,880	4,140	5,610	7,360	5,610	7,360	9,340	11,500
	3,140	4,520	6,110	8,040	6,110	8,040	10,200	12,550
	3,400	4,900	6,630	8,700	6,630	8,700	11,050	13,600
	3,690	5,270	7,140	9,360	7,140	9,360	11,890	14,650
	3,920	5,650	7,650	10,050	7,650	10,050	12,730	15,700
	4,180	6,030	8,160	10,710	8,160	10,710	13,590	16,730
	4,450	6,400	8,660	11,400	8,660	11 400	14 420	17,770
	4,710	6,780	9,180	12,060	9,180	12,060	15,300	18,810
	4,950	7,160	9,690	12,720	9,690	12,720	16,140	19,860
	5,490	7,900	10,700	14,100	10,700	14,100	17,850	21,990
	6,010	8,650	11,710	15,400	11,710	15,900	19,550	24,090
	12 and 18	12 and 20	14 and 20	14 and 24	14 and 26	16 and 24	16 and 30	18 and 36
	9,340	11,500	11,500	16,550	19,410	16,550	25,850	26,900
	10,200	12,550	12,550	18,050	21,200	18,050	28.120	40,250
	11,050	13,600	13,600	19,550	22,980	19,550	30,600	43 600
	11,890	14,650	14,650	21,030	24,720	21,030	32,950	47,000
	12,730	15,700	15,700	22,600	26,500	22,600	35,300	50,400
	13,590	16,730	16,730	24,040	28,220	24,040	37,850	53,600
	14,420	17,770	17,770	25,600	30,000	25,600	40,000	57,100
	15,300	18,810	18,810	27,050	31,800	27,050	42,350	60,400
	16,140	19,860	19,860	28,600	33,550	28,600	44,700	63 700
	17 850	21,990	21,990	31,600	37,100	31,600	49,500	70,500
	19,550	24,090	24,090	34,600	40,600	34,600	54.100	77,200

TABLE IV.—Total Plunger Loads for Various Heads and Various Sizes of Plunger.

Head		Plunger Diameters, in inches.										
Ft.	Lbs.	5	5½	6	6½	7	7½	8	8½	9	9½	10
50	21.7	426	515	613	719	835	956	1,090	1,260	1,380	1,535	1,710
75	32.5	637	770	918	1,075	1,250	1,430	1,635	1,845	2,070	2,300	2,560
100	43.3	850	1,030	1,225	1,435	1,670	1,910	2,180	2,460	2,760	3,070	3,410
125	54.1	1,060	1,280	1 530	1,790	2,080	2,390	2,720	3,070	3,450	3,840	4,260
150	65.0	1,275	1,540	1,835	2,160	2,510	2,870	3,270	3,690	4,140	4,610	5,120
200	86.6	1,700	2,050	2,450	2,870	3,340	3,820	4,360	4,900	5,510	6,140	6,310
250	108.3	2,125	2,565	3,060	3,590	4,170	4,780	5,450	6,140	6,900	7,680	8,510
300	130.0	2,550	3,080	3,679	4,310	5,000	5,740	6,540	7,360	8,270	9,210	10,220
350	151.6	2,970	3,590	4,280	5,020	5,830	6,680	7,630	8,580	9,650	10,730	11,920
400	173.0	3,380	4,100	4,890	5,730	6,661	7,630	8,720	9,800	11,030	12,250	13 610
450	195.0	3,830	4,620	5,500	6,460	7,500	8,600	9,810	11 050	12,410	13 800	15,350
500	217.0	4,260	5 150	6,130	7,190	8,350	9,560	10,900	12,300	13 800	15,350	17,100
		10½	11	12	13	14	15	16	17	18	19	20
50	21.7	1,880	2,060	2,460	2,880	3,340	3,830	4,360	4,920	5,550	6,150	6,820
75	32.5	2,820	3,090	3 680	4,320	5,000	5,740	6,520	7,370	8,270	9,210	10,200
100	43.3	3,760	4,120	4,910	5,750	6,650	7,650	8,700	9,850	11 050	12,280	13,600
125	54.1	4,690	5,150	6,120	7,190	8,320	9,560	10,880	12,300	13,790	15 360	17,000
150	65.0	5,630	6,180	7,360	8,620	10,000	11,490	13,060	14,750	16,550	18,410	20 410
200	86.6	7,500	8,240	9,800	11,500	13,320	15,300	17,400	19,700	22,050	24,550	27,220
250	108.3	9,400	10,300	12,250	14,350	16,680	19,100	21,800	24,550	27,600	30,700	34,100
300	130.0	11 250	12,350	14,700	17,200	20,000	22,980	26,100	29,500	33,100	36 830	40,900
350	151.6	13,150	14,400	17,160	20,050	23,300	26,800	30,400	34,400	38,600	43,000	47,650
400	173.0	14,990	16,450	19,590	22 950	26,6 0	30,600	34,700	39,300	44,100	49,150	54,400
450	195.0	16,900	18.550	22,100	25 900	30,000	24,450	39,180	44,300	49,650	55,300	61,300
500	217.0	18,800	20,620	24,600	28,800	33,400	38,300	43,600	49,300	55,200	61,500	68,200

speed being 125 ft., the capacity should be four-fifths that given, or 556 gallons, which requires a 12-in. plunger. In Table IV. the pressure on a 12-in. plunger under a head of 150 ft. is found to be 7,360 lbs. In Table I., if the pump is to work non-condensing, a steam end of 12 and 18-in. cylinders will carry 7,520 lbs. at a steam pressure of 80 lbs. In Table II., if the pump is to work condensing, 10 and 20-in. cylinders will carry 7,220 lbs. To determine whether it is economical to use the pump condensing or not would involve the question of cost of steam generation.

To get the emergency capacity, when, as is frequently the case it is desired to use the pump for fire pressure and there is steam capacity enough, live steam is used in both cylinders. We will assume that live steam at 90 lbs. can be supplied and that a piston speed of 150 ft. will be used. In Table III, a 12 and 18-in. end at 90 lbs. will carry a water load of 14,420 lbs.; which, on the 12-in. plunger (see Table IV.) is equivalent to a head of 300 ft. or 130 lbs., and the water discharged at 150 ft. per minute piston speed is (from Table V.) 1½ time 587, or 780 gallons per minute on each side, that is, 1,560 gallons total per minute. These quantities represent pump displacement.

Tables I. and II. also have a column headed "HP. at 100 ft. piston speed." This is to enable the steam end to be approximately determined without calculating the plunger size. Take a table of theoretical horsepower of water and note that 2,000,000 gallons in 24 hours or 1,390 gallons per minute at a head of 150 ft. is 52.8 HP.; that is to say, each half of the pump must develop 26.4 HP. net. Making allowance of 50% for friction loss in water ends (this should be more than 50% for outside packed pumps) this means 39.6 HP. to be developed in the steam end. As the desired speed is 125 ft., the horsepower shown in the table should be four-fifths of this or 30 HP. Then we see in Table I that a 12 and 18-in. steam end at 80 lbs. will develop 34.5 HP.

TABLE V.—Displacement of a Single Double-acting Piston or Plunger, Operating at a Speed of 100 ft. per Minute and Without Slip.

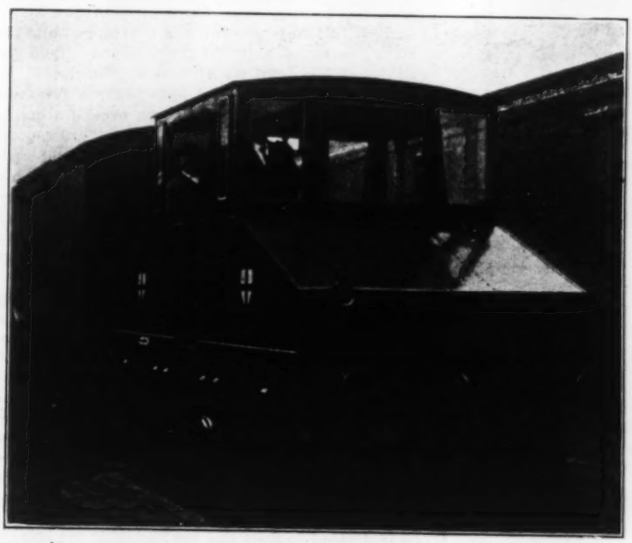
Diameter piston. ins.	Gallons per Minute.	Gallons per Hour.	Gallons per 24 hours.
1	4.07	244.7	5.875
1¼	6.37	382.5	9,180
1½	9.18	550.8	13,219
1¾	12.49	749	17,992
2	16.31	979	23,500
2¼	20.6	1,239	28 180
2½	25.5	1,530	36,720
2¾	30.8	1.851	44,424
3	36.7	2,203	52,878
3¼	43.1	2,586	62 064
3½	49.9	2,998	71 971
3¾	57.3	3,442	82,619
4	65.2	3,916	94,002
4¼	73.7	4,422	106,128
4½	82.6	4.957	118,971
4¾	92	5,523	132,552
5	102	6.120	146,880
5¼	112	6,745	161,934
5½	123	7,404	177 696
5¾	134	8,093	194,248
6	146	8,812	211,51:
6¼	159	9,562	229,500
6½	172	10,344	248,256
6¾	185	11.152	267,650
7	200	11,995	287 884
7¼	214	12.867	308,808
7½	229	13,769	330,478
7¾	245	14.700	352 300
8	261	15,667	376,011
8¼	277	16.660	399,852
8½	294	17.688	424,512
8¾	312	18,741	449,978
9	330	19,828	475,887
9¼	349	20,944	502,668
9½	368	22,092	530.208
9¾	388	23.280	558.720
10	408	24,480	587,518
10¼	428	25,716	617,184
10½	449	26,989	647,789
11	493	29,616	710,784
11½	539	32 374	776,993
12	587	35,251	846,046
12½	637	38,250	918,000
13	689	41,370	992,880
13½	743	44 610	1,070,640
14	799	47,980	1,151,536
14½	858	51,468	1,235,232
15	918	55.070	1,321,915
15½	980	58,800	1,411,200
16	1,044	62,668	1,504,046
16½	1,110	66,642	1,599,408
17	1,179	70,752	1,698,048
17½	1,249	74,964	1,799,136
18	1,322	79.314	1,903,550
18½	1,396	83,778	2,010 672
19	1,473	88.368	2,120,832
19½	1,552	93,120	2,234,880
20	1,632	97 920	2,350,080
20½	1,714	102,840	2,468,160
21	1,799	107,952	2,590,848
21½	1,886	113,154	2,715,696
22	1,974	118,482	2,843 568
22½	2.065	123,924	2,974,176
23	2,158	129,492	3,107 808
23½	2,253	135,186	3,244.464
24	2,349	140,958	3,382,992
24½	2,449	146,958	3,526,992
25	2,550	152,994	3,671,856
25½	2,653	159,179	3,820,300
26	2,758	165,484	3,971,630
26½	2,865	171,908	4,125,800
27	2,974	178,457	4,282 967
27½	3.085	185,130	4,443,125
28	3,199	191,922	4,606,125
28½	3,314	198,888	4,772,118
29	3,431	205.876	4,941.028
30	3,672	220,320	5,287 675

To compute the equivalent in Imperial gallons, multiply by .833.

AN ENGLISH PETROLEUM LOCOMOTIVE.

The Mandslay Motor Co., Ltd., of Parkside, Coventry, England, lately officially tested a new petroleum locomotive, designed and built by this company to the order of the City of London Corporation. It is to be used for hauling cars between the Corporation Meat Market and the London, Brighton & South Coast Railway stations.

The locomotive itself weighs about 12 tons, and the mechanism is entirely covered from view to conform with the Board of Trade regulations. It is intended to haul four trucks, which, when fully loaded, aggregate 50 tons, up a maximum gradient of 1 in 36, and on a railway of standard gage. The water and petroleum tanks are of sufficient capacity for a full day's work. The motor is the Mandslay Motor Co.'s standard design; with three 9-in. cylinders and 9-in. stroke, and the motor develops 80 B. HP. at 450 revolutions per minute. The motor is cooled by a large tubular radiator fitted with a fan; and for greater convenience an 8 HP. single cylinder engine is employed for starting.



AN ENGLISH PETROLEUM LOCOMOTIVE.

As the line traversed runs through streets and the market itself, the locomotive is so geared as to have two speeds of only 2½ and 5 miles per hour, in each direction. In addition to the ordinary handbrakes, the locomotive is equipped with the Westinghouse brake; and a sanding apparatus is employed when the streets are "greasy."

In the trial referred to, the full load of 50 tons was drawn over the line with the greatest ease, and the trial included stopping and starting again on the steepest grades. The controlling and reversing mechanism was especially satisfactory in its working.

A DYNAMITE EXPLOSION at the Trimmer quarry, near Somerville, N. J., Nov. 12, killed the son of the proprietor of the quarry. Several sticks of dynamite were being thawed by the office stove. With the advent of cold weather we may expect to hear of many similar accidents, for properly built hot-water thawers remain conspicuous by their absence in many quarries.

AUTOMATIC SPRINKLERS may be rendered inoperative or slow to operate by painting the operating parts or head. This fact has been discovered by removing the painted heads of a number of sprinklers and testing them. Particular difficulty was experienced when the painting had been done by spray machines. The offices of the Boston Manufacturers' Mutual Fire Insurance Co. warns owners of automatic sprinklers not to use heads that have been painted.

EXTENSION OF DAM AND PAVING OF RIVER BANK AT DES MOINES, IA.

By C. B. Burdick, C. E.*

The Des Moines Edison Light Co. is engaged in the business of the manufacture and distribution of electric light and power to the city and citizens of Des Moines, Ia. The main source of power is steam, but slightly more than 10 per cent. of the capacity is furnished by water power from the Des Moines River. The hydraulic plant, while small in capacity compared with the steam plant, is of considerable value in that at certain seasons it can be operated continuously, and at all times is run at full capacity so long as the water stored

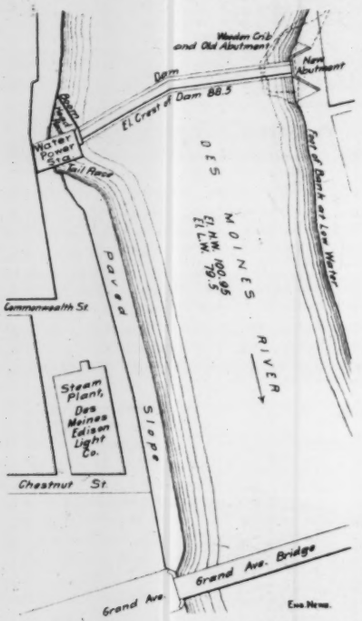


Fig. 1. Plan of Dam and River Bank Improvement at Des Moines, Ia.

in the pond holds out. It ordinarily supplies a considerable part of the day load.

The water power plant as remodeled consists of four 66-in. and one 61-in. Leffel vertical shaft special turbines, geared to a horizontal shaft, at one end of which are directly connected two 175 KW. generators. These generators are of the constant voltage type, and their output is turned into the station switchboard. No regulation is attempted in the water power station, the irregularities being taken up by the steam plant, a small portion of which is always in operation.

The dam was originally 355 ft. long and gives an ordinary head of about 8 ft. It is of pile and rock-fill construction, decked in with 4-in. oak planks protected from wear by old street railway rails. The abutments were of crib construction filled with stone and earth ballast. The dam rests upon a foundation of hardpan, soapstone or potter's clay, approaching rock in hardness at certain places; this is at a depth of 17 to 20 ft. below the crest of the dam, and about 9 to 12 ft. below tail

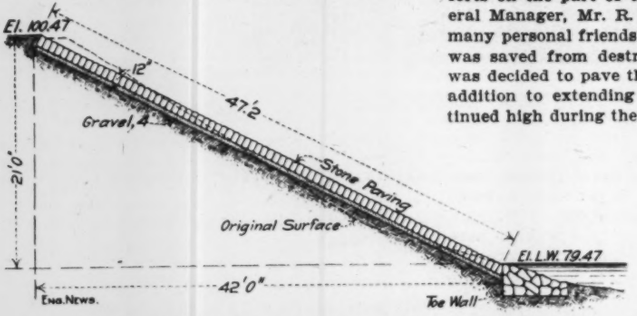


FIG. 2. CROSS-SECTION OF PAVING OF RIVER BANK.

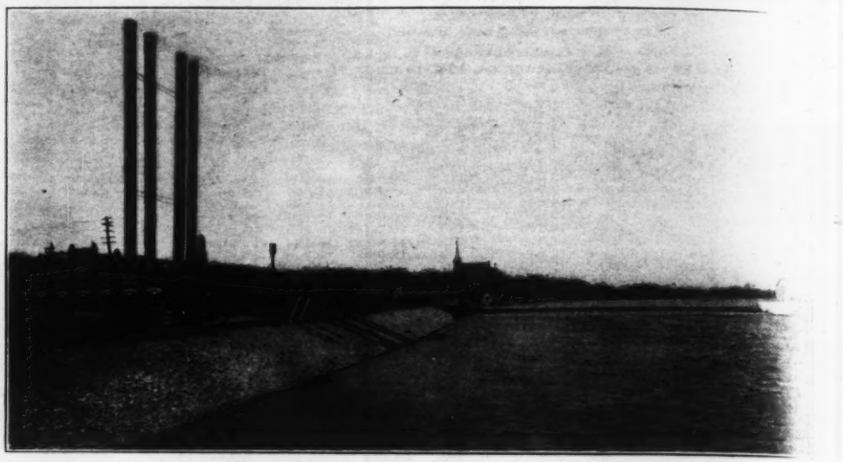


FIG. 3. VIEW OF DAM AND RIVER BANK IMPROVEMENT.

water. The piles in the old dam were set in bored holes. The wheel pits are of timber construction, enclosed by a frame building. The present dam and power plant were constructed about 14 years ago, at which time three of the present wheels were installed, the remaining two wheels were set sometime previously. The present dam succeeded a log dam built in 1847.

It will be noticed from the plan, Fig. 1, that the east abutment was originally constructed about 75 ft. out from the east bank, an earth embankment connecting the abutment with the shore. In 1902 this embankment was overtopped and the structure saved only by great effort. Upon the advice of Mr. John W. Alvord, M. Am. Soc. C. E., plans were prepared for a new concrete abutment located at the natural shore line, necessitating an extension of 56 ft. to the dam. As work could profitably be done only in the autumn, temporary repairs were made to the abutment which had been damaged during the 1902 flood; the temporary repairs successfully withstood the record flood of 1903, which again overtopped the embankment and inundated the greater part of East Des Moines.

The wisdom of restoring the channel to its original width was shown during this flood. The swift current was deflected by the projecting earth embankment and thrown against the west bank in front of the steam power house. The bank at this place consisted largely of cinder filling, and was so rapidly eaten away as to endanger the power house walls. It was only by the most heroic efforts on the part of the Vice-President and General Manager, Mr. R. H. MacMullan, assisted by many personal friends and citizens, that the plant was saved from destruction. After this flood it was decided to pave the west bank of the river in addition to extending the dam. The water continued high during the summer of 1903, and it was not until Nov. 2 that contracts were let and construction commenced.

Work was begun simultaneously on the extension to the dam and the bank protection on the west side of the river. At the same time extensive repairs were being undertaken to the water power station; these included two new wheel pits to replace those destroyed by fire sometime previously, and the setting of two new generators with the necessary shafting and gearing.

The bank protection upon the west side of the river consisted of stone pavement laid in a slope of 2 horizontal to 1 vertical. The toe of the slope is protected by means of a dry wall of large stones, the chinks being filled with smaller stones. This wall was all laid below water line, and was constructed as shown in Fig. 2. In constructing the toe wall, a cofferdam was used consisting of a double layer of 3-in. planks driven into the river bottom as sheet piling and braced by a frame of 8 × 8-in. timbers resting against the bank; manure was packed outside the sheeting planks to aid in stopping the leaks. Upon the deeper sections two rows of sheeting planks about 3 ft. apart were used, with manure packed between the rows. The water was drawn down about 2 ft. inside the sheeting by means of an 8-in. centrifugal pump belted to a stationary engine with boiler at top of the bank. The engine, boiler and pump were set on skids and moved as the work progressed. The cofferdam was constructed in sections varying in length from 50 to 100 ft.

The largest of the stones were selected for use in the toe wall; no stone of less than 0.66 cu. ft. was used except in filling the chinks; at least half the stones exceeded 1 cu. ft. After the toe wall was laid, the bank was trimmed for the pavement. The trimming was principally all in cut, there being only a small amount of fill close to the toe wall. The banks having been brought to grade, a 4-in. layer of gravel was spread, upon which was laid a 12-in. course of stone on edge. The stone used was brought from Forestville, Ia., and is a fair quality of limestone.

In laying the pavement the stones were roughly dressed with the hammer so that when laid the joints should not exceed 1½ ins. for a distance of 4 ins. below the face of the pavement. All stones were laid with their largest dimensions parallel to the river. No stone was used less than 3 ins. in thickness, and a majority of the stones were 4 ins. thick or more. The specifications stated that the courses need not be uniform in thickness or

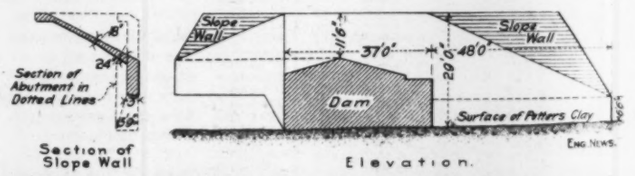


FIG. 4. CROSS-SECTION OF DAM, ABUTMENT AND SLOPE WALLS.

continuous. The cost of the bank protection was as follows:

Cost of bank pavement per sq. yd.:	
Stone	$0.92
Labor and sand (contract)	1.25
Total	$2.17
Cost of toe wall per lin. ft.:	
Stone	$1.01
Labor (contract)	3.00
Total	$4.01

The stone cost from $1.95 to $2.05 per perch of 25 cu. ft. on the river bank. Gravel cost 75 cts. per cu. yd. delivered. The cubic contents of the

*127 Hartford Building, Chicago.

vement and toe wall as laid is equal to 1,727 cu. ds., or 1,864 perches. The stone purchased as easured loose in cars amounted to 2,236 perches. he ratio of the volume, therefore, of loose stone the volume as laid in place, was 1.2. The nstruction of the toe wall was started Nov. 14, d was completed Jan 1, 1904. The least length toe wall laid in one week after the work was ll organized was 70 ft., and the greatest week's ork was 306 ft. Fig. 2 is a section of the paving, d Fig. 3 is a view showing the paved bank and e completed dam.

the customary vertical walls. This is shown in Figs. 4 and 5, and by this method of construction something over 500 cu. yds. of concrete was saved. The slope walls were laid upon the natural clay of the river bank after the frost had left the ground. The abutment rests upon rock foundation.

In extending the dam, the excavation was carried down to 3½ ft. below tail water, leaving about 8 ft. of clay and sand above rock or hardpan surface, to which the piles were driven. A double row of 3-in. sheet piles was driven to hardpan

was experienced in keeping the pumping machinery in operation. From Nov. 2 until April 1 there were from all causes 17 days upon which no work was done. The work was suspended upon 12 days due to inclement weather.

The improvements were planned and carried out under Mr. John W. Alvord, M. Am. Soc. C. E., as Consulting Engineer; the writer had direct charge of the preparation of plans and supervision of construction; Mr. A. H. Moss acted as resident engineer; Mr. J. W. Turner, of Des Moines, was contractor for the dam and bank

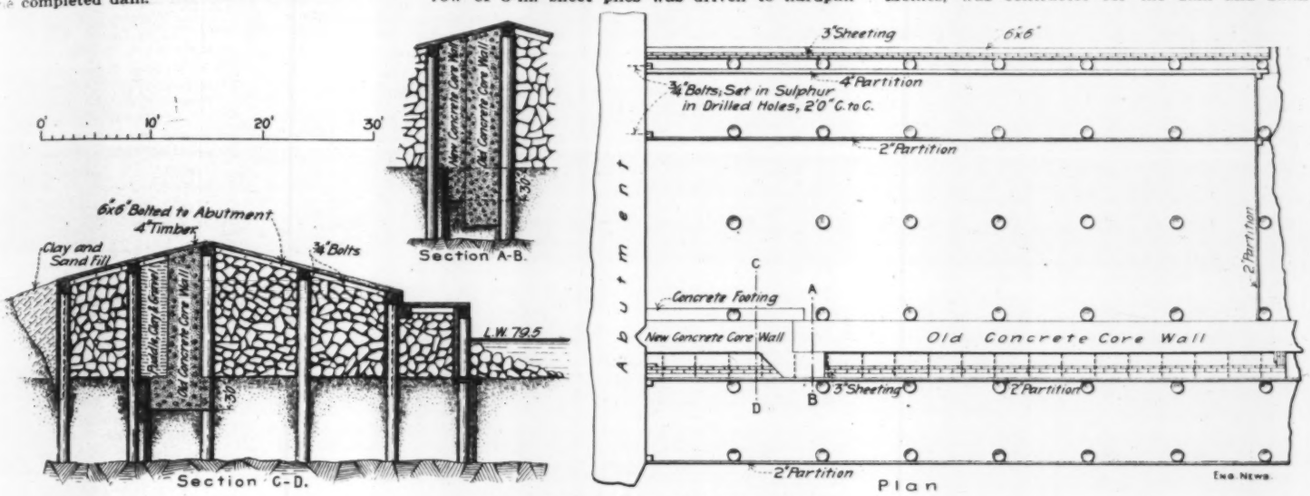


FIG. 6. DETAILS OF DAM EXTENSION.

In constructing the east abutment and extension to the dam, all work was done within the lines of the enbankment shown upon the plan, Fig. 1. The abutment was first constructed and the dam was built from the abutment outward, the connection with the old dam being made last. The remains of the old abutment were not removed until all was ready for connecting with the old work. In making the connection, the water which was passing over the old dam (6 to 12 ins. deep) was dammed off with excavated material.

The abutment is constructed of concrete composed of 1 part cement, 4 parts sand and gravel, and 5 parts crushed stone. About one-third of the sand and gravel consists of stones ⅛-in. in size and larger. The concrete amounted to 735 cu. yds. and was all mixed by hand. Of necessity all the concrete, except 98 cu. yds. in the slope walls, was laid in freezing weather, the mercury being sometimes as low as 15° above zero. The sand and stone were warmed in ovens, and the water was warmed by a steam jet discharging into a steel tank wagon. The concrete has given no evidence of injury due to freezing.

The form of the abutment is somewhat unusual in that the wings consist of slope walls instead of

along the down-stream edge and also the up-stream edge of the dam. The old concrete core wall 3 ft. in thickness within the old enbankment was extended about 15 ft. to connect with the new abutment. Fig. 6 shows the character of construction, and Fig. 7 shows the work in progress.

Considerable difficulty was experienced in driving the sheet piles owing to numerous small stones encountered in the material through which piles were driven. A light pile driver with 25-ft. leads and 1,100-lb. hammer was swung from the boom of the derrick used in handling excavation and concrete. The hammer was lifted by the steam winding engines. The average cost of driving the sheet piles was $7.05 per lin. ft. of double row. The material cost $2.91 per lin. ft. The use of the sheet piling reduced the cost of the dam very materially as compared with the expenditure which would have been necessary to carry the structure to hard bottom.

Excavation below the water line was begun about Dec. 20, 1903, and the structure was completed on April 1. Operations were continued day and night after Jan. 1. The river remained at practically low water during the entire construction, but the weather was unusually severe, and much difficulty

protection. The General Electric Co. was represented by the engineer of the local companies, Mr. F. L. Dame.

ELECTROLYTIC CORROSION OF WATER PIPES AT BAYONNE, N. J.

A break in an important branch water main at Bayonne, N. J., about three months ago, led the authorities of that city to have an electrolysis survey carried out. Mr. A. A. Knudson, M. Am. Inst. Elec. E., of New York City, was entrusted with the work. The results of his investigation, summarized by him in a report to the Mayor and Common Council of the city, reveal serious conditions as to stray electric railway currents and electrolytic corrosion of underground metals in Bayonne. We are able to present an abstract of his results herewith.

The interest and seriousness of the question of stray current electrolysis lie not in the rarity or mysterious nature of the phenomenon; for the phenomenon is neither rare nor mysterious. On the contrary, it is just because electrolytic corrosion of this nature is widespread, and because it has in but few cases been "surveyed" or investi-

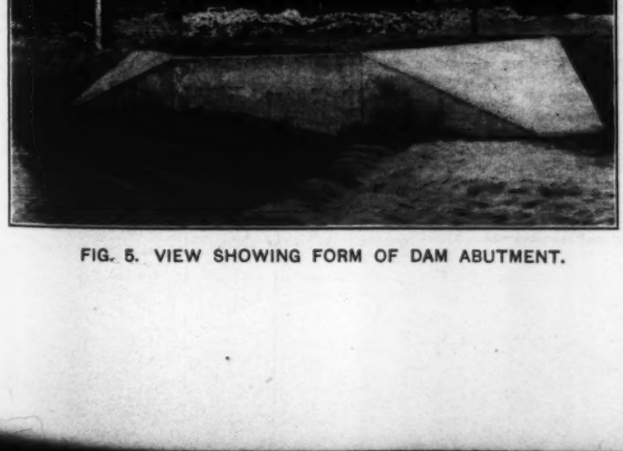


FIG. 5. VIEW SHOWING FORM OF DAM ABUTMENT.

FIG. 7. BUILDING THE EXTENSION OF THE DAM.

gated, that so much interest attaches to the relatively few cases where a more or less thorough study has been made. The matter is also of very great interest because, while the responsibility for the electrolytic injuries to underground mains is clearly upon the trolley companies, the first well contested suit to bring home the responsibility in judicial proceedings has been held up in a Western court for some years, although the complainant is anxious to bring it to a close. There are small prospects of this suit being decided in the near future.

The Bayonne case presents a clear and simple aspect, because of the fact that the electrolytic effects are of the same character throughout the entire outer edge of the city. The case differs herein from the ordinary one, where there is a fairly well defined "positive district" in which most of the damage occurs. The corrosion of a lead service pipe at Bayonne is also a noteworthy feature.

We have omitted as much of the report as is not essential to an understanding of the nature and extent of the damage done, but have given the remainder practically in full, for reasons above indicated. It may be explained here, as not stated in the report, that the measurements of currents carried in the pipes, made by measuring the fall of potential in a given length of pipe, are based on Mr. D. H. Maury's tables, which are known to correspond closely, on the average, to the actual current conditions. While the values of current flow given in the summary of observations, Table I. herewith, may err to some extent one way or the other in individual instances, they may be taken as correct on the whole:

The street railway lines enter Bayonne from Jersey City, crossing the northern city limits at the Morris Canal, and pass through Avenue C to 10th St., thence to Avenue D and to 5th St., thence back to Avenue C and to a terminus at 1st St. and Staten Island Ferry. The return is over the same route, the road being double-tracked. A branch line connecting at Avenue C runs through East 22d St. as far as Avenue I, the terminus being near the Standard Oil property on Constable Hook; this is also a double-track road and two cars are at present used on this line. Another branch line runs through West 5th St. Intersecting the main line at Avenue C, it runs west to Avenue A and to the terminus near Bayview Court. This line has a double-track, but one only is used for the one car on the line.

Voltmeter readings were commenced at the northern end of the city at 54th St., and covered all of the lines. All of the tests between mains and rails show mains negative to rails, which, of course, means rails positive to mains, current leaving the tracks and taking the mains in all streets of the city where they parallel. There is no "positive area" in the city, in the sense of mains positive to *rails*. This is due to the fact that the powerhouse is located in Jersey City, some five miles from the central part of Bayonne.

The readings on Avenue C between mains and rails are such as may be expected upon a fairly well-bonded road, and the same may be said of the tracks upon 22d St. The 5th St. Line, however, presents a case of rank negligence so far as the track return is concerned. The voltmeter readings and other observations show the tracks unbonded at the joints, and not carrying current except perhaps when the car is a few feet from the main line. Differences of potential, from practically nothing when the car is at rest up to 12, 18 and 25 volts when the car is moving, have been found. Residents along the route report frequent illuminations at the track joints. The rails, therefore, affording practically no return for the current, it must make its way back to the powerhouse by the water mains to the shore, thence through the waters of New York Bay and Newark Bay to the powerhouse, which is located on the marsh near the shore.

We find as a result of measurements that there are two paths by which the returning railway current which enters the mains passes back to the powerhouse. One of these paths is in a northerly direction by way of mains passing into Jersey City; some of the current goes by way of the 20-in. main which crosses the canal bridge at Avenue D and connects with the mains in Jersey City, and some goes by way of the large supply main which passes into Jersey City further to the west. The other path and outlet for current flow has been found to be at the shore ends of practically all mains that extend to tidewater, the current going thence through the water to the powerhouse.

In many previous electrolysis surveys by the writer, several cases have been found where the returning trolley current has followed mains to a river bed or shore line, and thence leaving them for the wet soil, passes through such shore line to the powerhouse, which is located usually on the same waterway. Entrance of this current to the powerhouse is generally by way of the intake and outlet pipes of the condensing apparatus, or by the station "ground."

The first path mentioned for the returning current in Bayonne, therefore, gives us but little concern, as the current is delivered beyond the city limits into other people's property; except as it may cause damage in future to the joints of the mains through which it must pass. The second path, however, is most important, as, owing to the geographical position of the city, surrounded as it is by salt water, with large areas of marsh, in which several mains are imbedded, the conditions are very favorable for electrolytic action at many places.

CONDITIONS WHERE BREAKS OCCURRED.

MAIN IN EAST 22D ST.—The corrosion and break of the 12-in. main in East 22d St. is most important, as upon this main several important industries at Constable Hook depend for water. According to the records in the Water Purveyor's office, this main burst during the night of August 6, 1904, causing much loss in time and money to works depending on same for water; owing to the break being under tidewater, great trouble and expense was incurred in making repairs. Besides this, we are informed that some 4,000,000 gallons of water went to waste before the leak could be located and water shut off.

This leak took place in the made street crossing the salt meadows, about 300 ft. east of Avenue F, and near a culvert through which a tidal creek passes under the street. It being evident from a few tests that railway current was passing out of the main into the soil at this point, thus causing the damage, we have given special attention in our examination of this case, so that all the facts contributing to such cause may be obtained.

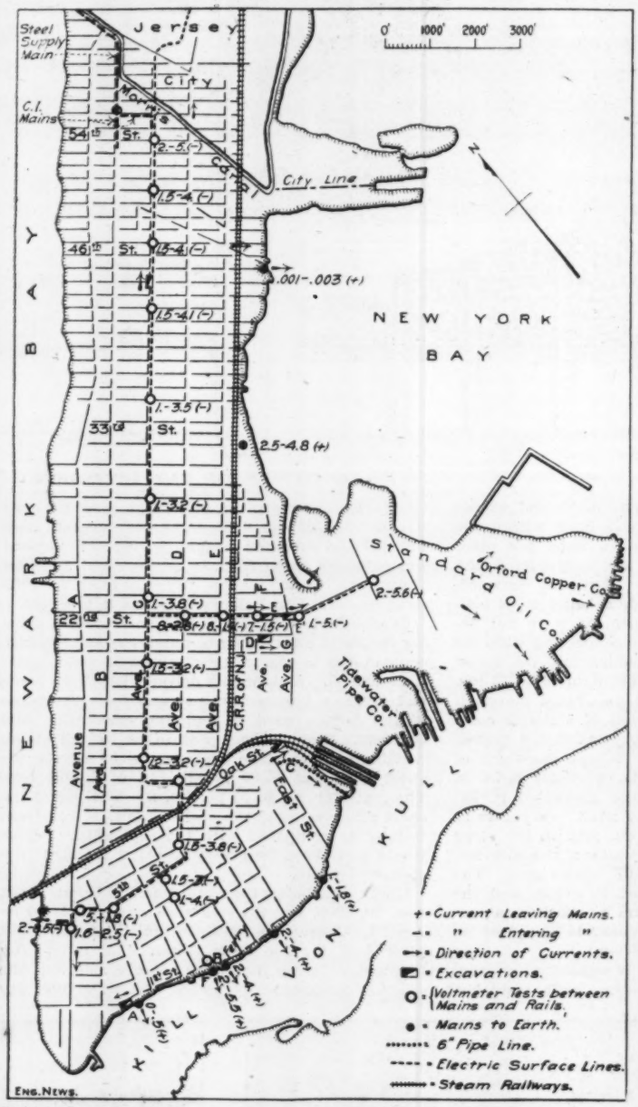


FIG. 1. MAP OF BAYONNE, N. J., SHOWING RESULTS OF AN ELECTROLYSIS SURVEY MADE BY MR. A. A. KNUDSON, SEPTEMBER, 1904.

(The water system is supplied from a steel main of the New York & New Jersey Water Co., at the northern city line, where the cast-iron pipes of Bayonne begin. The street railway also enters at the northern boundary from Jersey City.)

Through what is known as the "fall of p[otential]" method of ascertaining the amount of current-f[low] in a main, we have taken measurements at two pla[ces] on this main, one at each side of the marsh where [the break] occurred, the object being to determine by com[parison] of the readings how much of this trolley curr[ent is] passing off from the main into the marsh.

The main was uncovered for this purpose in 22[d St.] at Avenue F and also near Avenue G (points E and [E] Fig. 1). The comparison tests were made betwe[en] 5.30 p. m. at each place, on two different days, [when] the condition in regard to traffic on the cars w[as] about the same when each test was made. The re[sults] these measurements are found in the table of [the] measurements.

As will be seen, they show that the trolley curren[t in] the main is flowing east[ward] a decrease of current [in the] marsh, which decrease [is] countable for the break. [The] decrease, representing cu[rrent] *leaving* the main at this [point] undoubtedly is at present [causing] ing further damage to [the] main. For instance, refe[rring] to the readings taken at [the] comparison test:

Avenue F.
Max. 51.1 amp.
Min. 21.9 " = Av. 36.5

Avenue G.
Max. 25.5 amp.
Min. 14.6 " = Av. 20.0

Av. drop.....16.5 amp.

This average, 16.5 amperes or 45% of the average at Avenue F, is passing out of the main into the marsh for about two hours during the heavy traffic in the evening, and similarly for about two hours during the early morning, between 5.30 and 7.30, or for at least four hours out of the entire day. During the remaining 20 hours the current varies according to the traffic on the cars. As was shown by night tests, the average current after 12 o'clock is between 3 and 6 amperes passing from the main, while during the day the average may vary from 8 to 12, up to that already cited for the period of evening traffic.

Permanent connections have been made upon the main at Avenue F with insulated wires, and the ends brought to the surface of the street through a pipe covered with a screw cap, so that readings may be conveniently taken without further disturbing the street. By this means a future watch may be kept of the current flow through this main and the amount of current corresponding to 45% drop in the marsh may be computed.

Confirmatory of the measurements and drop, two potential tests were made between the main and soil of the marsh. One, nearest where the break occurred, showed a reading, with main positive to soil, of 300 to 700 milli-volts, or 0.3 to 0.7 volts.

A photograph of a portion of the main where the break occurred is shown in Fig. 2 herewith. It plainly shows the effects of electrolytic decomposition in the carbonized condition of the iron.

The other 55% of the current on the 12-in. main, flowing past the marsh, is distributed through various other pipes and metals at the lower Hook, and thence to soil, causing damage wherever it leaves the metal. One of these places is an 8-in. main near the Orford Copper Works, Lower Hook, which burst on March 21, 1904. This pipe also showed clear evidences of having been destroyed by electrolytic action.

It was first supposed that the current on the 12-in. main came mostly from the cars operating in 22d St. The night tests, however, showed that this is not the case, as the readings were taken after 12 o'clock when the two cars had ceased running, and were off the line. A large portion of the current on the main comes from the Avenue C line. Four cars are run on this line after 12 o'clock through the night.

MAIN IN FIRST ST.—Another case of an electrolysis break occurred on 1st St. and Rathbun Avenue, in March, 1902 (point A, Fig. 1). This is a 6-in. main; the break was repaired. During the present investigation this main was uncovered where the new piece was put in and measurements taken. The main is reached by tidewater and was found positive to the soil. The flow of current through the main was west, with a variation from 5.2 to 12 amperes. No signs of electrolysis were found upon the new length at the top and sides. The lower part was in water and could not be examined. As the current is flowing towards the west, it is believed that it is coming out and causing injury but a short distance from this point, and further damage is looked for upon this main. (See also Appendix II. to this report.)

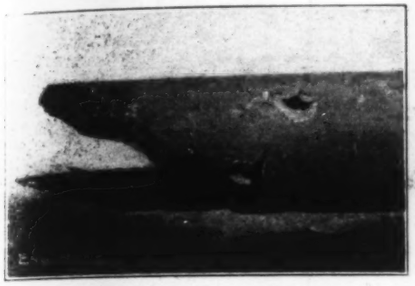


Fig. 2. Photograph of Piece of 12-in. Water Main Destroyed by Electrolysis at Bayonne, N. J.
(Taken from point E, Fig. 1, September, 1904.)

Tests and measurements show that the most if not all of this current comes from the single car operating on 5th St. There are three mains connecting with the 5th St. main which run south through Avenue A and neighboring streets and connect with the main in First St. The tests on Avenue A, where the movements of the car could be watched, were very significant, as at starting, rounding curves or ascending grade, sudden jumps of the instrument needle were observed. In this way the source of return current destroying this main is plainly identified.

MAIN AT THE COAL DOCKS.—This main enters the salt marsh near East Avenue and Oak Street (point C, Fig. 1), and up to a short time ago practically all of it was entirely under tidewater in the marsh. According to the records in the Water Department, there have been removed 420 ft. of this pipe, and about the same length was left in the marsh as being unfit for further use, making about 840 ft. destroyed. We have examined each one of the 35 lengths taken out of the marsh and find every one of them to show the characteristic marks of electrolysis.

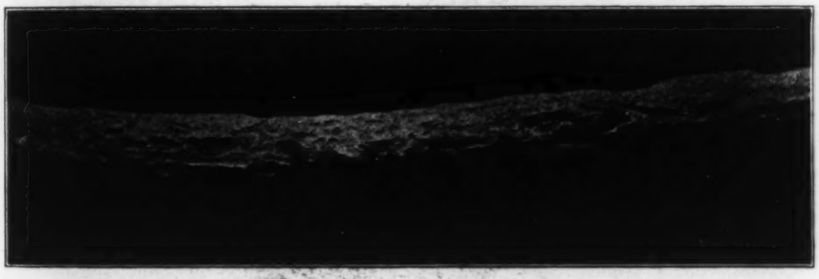


FIG. 3. LEAD SERVICE PIPE DESTROYED BY ELECTROLYSIS AT BAYONNE, N. J.
(Taken from point D, Fig. 1, Sept. 19, 1904.)

The electrical measurements on the main now in use show clearly the cause of electrolysis and the destruction of the pipe removed. Tests made near the meter box where the main enters the marsh at East Avenue and Oak Street show a flow of trolley current going east ranging from 2 to 4.6 amperes. Potential tests show that the main is positive to the marsh by upwards of one volt.

The new main when tested had been removed from the marsh and placed above the ground on supports for about 1,000 ft., then entered the marsh. Beyond the entrance point, about 150 ft. east, the main was again exposed above the surface, and a measurement showed a small reading of from 0.1 to 0.5 amperes, which measurement goes to confirm the potential test, that the current discovered on this main at the meter box flowing east goes out into the marsh wherever it may be in contact with same.

These conditions, therefore, are all favorable for bringing about just what has happened, viz.: the destruction by electrolysis of this entire line of cast-iron pipe.

LEAD SERVICE PIPE.—Another most pronounced case of electrolysis was discovered while this examination was in progress by the bursting of a lead service pipe supplying water to Annex to School No. 5, located on 21st Street and Avenue F. The piece containing the break is shown in Fig. 3 herewith. The leak was discovered Sept. 19, 1904 (point D, Fig. 1).

A portion of the pipe remaining in the ground has been examined and we find it to be in a very similar condition to the piece removed. From the electrical conditions discovered, we have to say that railway current is leaving this pipe for the marshy soil, and another failure of this pipe is predicted in a short time. (See also Appendix I.)

SUMMARY.—All of the damage to the water mains in the city caused by electrolysis is due to the railway current passing out from them to tidewater soil. No case has been found where it passes back to the rails; and in this sense there is no so-called "positive district" in the city.

The remedy for electrolysis upon the water mains of Bayonne rests with the street railway corporation operating its cars there. There are other ways than the "ground return" to bring currents back to the powerhouse in Jersey City. So long as the "ground return" is in use, so long will the currents find their way to the mains and pass out of them in the manner which we have described.

There are copper return systems in use, insulated from the ground, and from which no injury to underground mains by electrolysis is caused.

The full extent of damage by electrolysis to the water mains in Bayonne may not be known until those in the marshes and water front have been removed. In several cases, as in 22d St., being under tidewater, they are impossible to examine. It is safe to conclude, however, from the experience of the 6-in. pipe to the Coal Docks (point C, Fig. 1) and from what has already occurred on the 12-in. main in 22d St., that the latter main is practically ruined where it passes through the marshy soil, for at least 1,500 ft. The loss of the 840 ft. of 6-in. main through electrolysis has already been stated.

We have not yet mentioned the destructive effects upon the joints of mains where these railway currents are flowing through them. This feature of electrolysis is very difficult to locate because it is hidden. The result, however, is to cause joints to leak, causing much expense to the city for repairs. This flow of current prevails at present through a large part of the entire piping system, and if it has not already appeared it will in time make itself known.

TABLE I.—Measurements of Current on Water Mains.

Date, 1904.	Location.	Size Main, Ins.	Current in Amperes. Min.	Current in Amperes. Max.	Direction.	Notes.
Sept. 19	Canal Bridge, Ave. D	20	5.0	14.0	N.	Flow towards P. H. in Jersey City
Sept. 21	East Ave. and Oak St. Coal Docks	6	2.0	4.6	E.	840 ft. of this pipe destroyed by electrolysis.
Sept. 21	At t. ¼ mile E. of above test, same pipe	6	0.1	0.5	E.	
Sept. 21	Columbia Oil Works	8	0.0	1.4	W.	Constable Hook.
Sept. 22	Ave. C and 43d St.	8	1.0	5.4	N.	Uncovered in making repairs.
Sept. 22	150 ft. east of Copper Works	8	0.7	0.9	E.	Badly pitted.
Sept. 22	200 ft. East of last opening	8	0.6	0.9	W.	
Sept. 20	*22d St. and Ave. F	12	8.0	33.2	E.	11 a. m.
Sept. 27	" " "	12	15.0	29.2	E.	Noon.
Sept. 27	" " "	12	21.9	51.1	E.	5 p. m.
Sept. 22	" " Ave. G	12	14.6	25.5	E.	5 p. m.
Oct. 1	" " Ave. F, Night	12	14.6 / 0.0	29.2 / 14.6 †	E.	Electrolysis break in this main bet. Aves. F and G.
Sept. 26	1st St. and Rathbun Ave	6	5.2	12.0	W.	New piece replacing electrolysis break March '03.
Sept. 26	46th St. Ry. Bridge	6	1.5	3.5	E.	Pipe enclosed in box.
Sept. 26	32d St. Ry. Bridge	6	1.0	2.5	E.	
Sept. 26	Ave. B and 55th St.	24	8.4	33.6	N.	In meter vault.

*Av. Min. and Max. at Ave. F, 5 p. m. .....33.5 amp.
Av. Min. and Max. at Ave. G., 5 p. m. .....20.0 amp.

Av. current lost in marsh..... 16.5 amp. = 45%

†Low and high readings from 13 tests made between 12 and 1 a. m. Current flow decreases to latter figures at 12.45. Estimated average flow after 12 midnight, 12.7 amperes. If 45% of this leaves main in marsh, this is 5.7 amperes.

APPENDIX I., OCT. 14, 1904.

Since the completion of this report, the following additional casualties to water pipes have occurred:

The lead service pipe at Annex to School No. 5 (point D, Fig. 1), mentioned in the report, with the prediction that "it would again fail in a short time," was again found leaking, and on Oct. 10 the entire length—about 120 ft.—leading from the main to the school building was removed and a galvanized iron pipe put in its place. This iron pipe is subject to the same effects of electrolysis, but it will probably take a little longer time to cause its destruction than the lead. We have seen the lead pipe which was removed, and it has the usual stamp of electrolysis throughout its entire length.

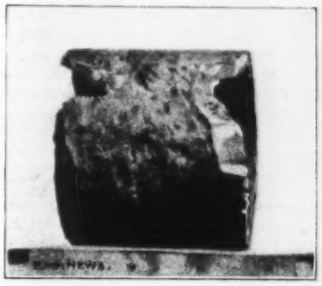


Fig. 4. Six-Inch Main, First St., Bayonne, N. J.
(Second break, Oct. 31, 1904; see Appendix II. of report.)

Another service pipe destroyed by electrolysis is being removed from First St., at the old Staten Island Ferry (point B, Fig. 1). One portion of this 3-in. iron pipe was found full of holes, caused by the escaping current. We have also been informed that the service pipe at the new ferry slip adjoining is eaten through in about eighteen months' time. Our electrical tests, at both the old and the new ferry slips, show the current flowing from the pipes to the Kill, and fully explain the cause of the failure at both places.

APPENDIX II., OCT. 31, 1904.

A further break occurred on the 6-in. main in First St. about 2 o'clock on the morning of the 31st of October. This failure (point F, Fig. 1) took place about one block west of Avenue C. A soft spot in the main about 2 ins. in diameter was blown out, and by a singular coincidence was in such position on the pipe that the stream of water coming out of the main forced its way through the soil and went over into the Kill von Kull some 50 ft., very similar to a stream directed from a fire hose. On this account there was no damage by water to nearby property. The shutting off of water to repair this break, however caused a serious loss and inconvenience to residents and others on this street. The large manufacturing establishment of the Safety Insulated Wire Co. was compelled to close its works for an entire day, leaving several hundred men idle, owing to loss of water which this main supplied.

The electrical tests taken at this point show the main highly positive to the waters of the Kill. This test coincides with other tests previously made upon this main, as shown in this report. The readings were highest at the foot of Avenue C at the ferry, growing smaller as they were taken east and west of that point. They ranged at the ferry from 2 to 5.5 volts; a little further west where the break occurred somewhat lower and 0.5 of a volt further west at Rathbun Ave. East of Avenue C or the ferry the conditions are quite similar to those upon the west side. We have personally examined this main near the fracture and find it to be softened entirely through the iron, with several other pittings upon other parts of its surface. Fig. 4 shows a piece of this main. From all the data collected, we have to say that this break is a clear case of electrolysis, for which the railway company's currents of electricity are directly responsible, and, as before stated, further breaks may be expected while these currents are present upon this main.

THE MINERAL PRODUCTS OF THE UNITED STATES AND THEIR VALUE.

The U. S. Geological Survey has just issued its annual bulletin, giving in tabular form the quantity and value of the mineral product of the United States for the last calendar year, with similar figures for preceding years. We reprint herewith the portion of the table giving the figures for 1903, together with a table giving the annual value of mineral products for each year since 1880. It will be seen by this latter table

that the value of mineral products in 1903 exceeded by far that for any year on record. The billion-dollar mark was first passed in 1900; and 1902 represented undoubtedly the climax of the boom which began near the close of 1897. It will be seen that the value of metallic products in 1903 was actually 18 million dollars less than in 1902; but this was more than offset by the enormous increase in the production of coal, particularly of Pennsylvania anthracite and the large advance in price at which it was sold. The detailed figures show an increase of 1903 over 1902 of 22 million tons of bituminous coal and 30 million tons of anthracite, while the total increase in values for both classes of coal reached 137 million dollars. Add to this $23,000,000 for increased value of petroleum produced in 1903, and it is seen that the fuel products alone account for 160 million dollars of the increase of value of 1903's mineral products, or almost exactly the amount by which the year showed a gain over 1902.

Turning to other figures: The quantity of pig iron produced in 1903 was greater than in any previous year, but lower prices made the total value less than in the boom year, 1902. It is interesting to look back and see that in 1894 only 6½ million tons of pig iron were produced, which were valued at 65 million dollars. It will be seen that in 1903 nearly three times the quantity of pig iron was produced and the price per ton was nearly doubled.

The silver production has remained very steadily at between 50 million and 60 million oz. per annum for ten years past. Gold production has shown a large increase since 1894, when the output was less than 2,000,000 oz.; but the 1903 product was less than that of 1900, 1901 or 1902. Copper production eclipsed all records, both for quantity and values.

The production of cement shows the huge total of nearly 30 million barrels, valued at nearly 32 million dollars. This includes both natural and Portland cements. In 1894 the total production of cement was only 8⅓ million barrels, and it was valued at only 5 million dollars. The value is taken at the place of production and the bulk of the product in 1894 was natural cement, which accounts for the low price per barrel.

Mineral Products of the United States in the Calendar Year 1903.

(Statistics Collected by the U. S. Geological Survey.)

PRODUCTS.	1903. Quantity.	Value.
METALLIC.		
Pig iron.....long tons	18,009,252	$344,850,000
Silver.....troy oz.	54,300,000	70,206,060
Gold..... "	3,560,000	73,591,700
Copper.....lbs.	698,044,517	91,506,006
Lead.....short tons	280,000	23,520 000
Zinc..... "	159,219	16,717,995
Quicksilver.....flasks	35,620	1,544,934
Aluminum.....lbs.	7,500,000	2,284,900
Antimony.....short tons	3,128	548,433
Nickel.....lbs.	114,200	45,900
Platinum.....troy oz.	110	2,080
Total value of metallic products.....		$624,318,008
NON-METALLIC.		
Fuels:		
Bituminous coal...short tons	282,749,348	$351,687,933
Pennsylvania anthracite, long tons.....	66,613,454	152,036,448
Natural gas.....		35,815,360
Petroleum.....bbls.	100,461,337	94,694,050
Structural materials:		
Brick clay.....		15,000,000
Cement.....bbls.	29,899,140	31,931,341
Stone.....		67,960,468
Abrasive materials:		
Corundum and emery, short tons.....	2,542	64,102
Crystalline quartz..short tons	8,938	76,908
Garnet for abrasive purposes, short tons.....	3,950	132,500
Grindstones.....		721,446
Infusorial earth and tripoli, short tons.....	9,219	76,273
Millstones.....		52,552
Oilstones, etc.....		366,857
Chemical materials:		
Arsenious oxide...short tons	611	36,696
Borax, crude..... "	34,430	661,900
Bromine.....lbs.	598,500	167,580
Fluorspar.....short tons	42,523	213,617
Gypsum..... "	1,041,704	3,792,943
Lithium..... "	1,155	23,425
Marls..... "	34,211	22,521
Phosphate rock.....long tons	1,581,576	5,319,294
Pyrite..... "	233,127	1,109,818
Sulphur.....short tons		
Salt.....bbls.	18,968,089	5,286,988
Pigments:		
Barytes (crude)....short tons	50,397	152,150
Cobalt oxide.....lbs.	120,000	228,000
Mineral paints.....short tons	62,122	646,222
Zinc white..... "	62,962	4,801,718
Miscellaneous:		
Asbestos.....short tons	887	16,760
Asphaltum..... "	101,255	1,005,446
Bauxite.....long tons	48,087	171,308
Chromic iron ore... "	150	2,250
Clay (all other than brick) short tons.....	1,650,835	2,649,042
Feldspar.....short tons	41,891	256,733
Fibrous talc..... "	60,230	421,600
Flint..... "	55,233	156,947
Fuller's earth..... "	20,693	190,277
Glass sand..... "	823,044	855,828
Crystalline graphite.....lbs.	4,538,155	225,554
Amorphous graphite....tons	16,591	
Limestone for iron flux, long tons.....	12,029,719	5,423,732
Magnesite.....short tons	3,744	10,595
Manganese ore.....long tons	2,825	25,335
Mica, sheet.....lbs.	90,100	17,128
Mica, scrap.....tons	1,693	41,990
Mineral waters.....gals. sold	51,242,757	9,041,078
Monazite.....lbs.	862,000	64,630
Zircon..... "	3,000	570
Precious stones.....		321,400
Pumice stone.....short tons	885	2,665
Rutile.....lbs.		
Talc and soapstone, short tons	26,671	418,460
Uranium and vanadium short tons.....	19	5,625
Total value of non-metallic mineral products.....		$794,403,561
Total value of metallic products.....		624,318,008
Estimated value of mineral products unspecified.....		1,000,000
Grand total.....		$1,419,721,569

FAILURE OF A BRIDGE SPAN AT NEW GLASGOW, NOVA SCOTIA, ON THE INTERCOLONIAL RY.

A BRIDGE FAILURE AT NEW GLASGOW, N. S.

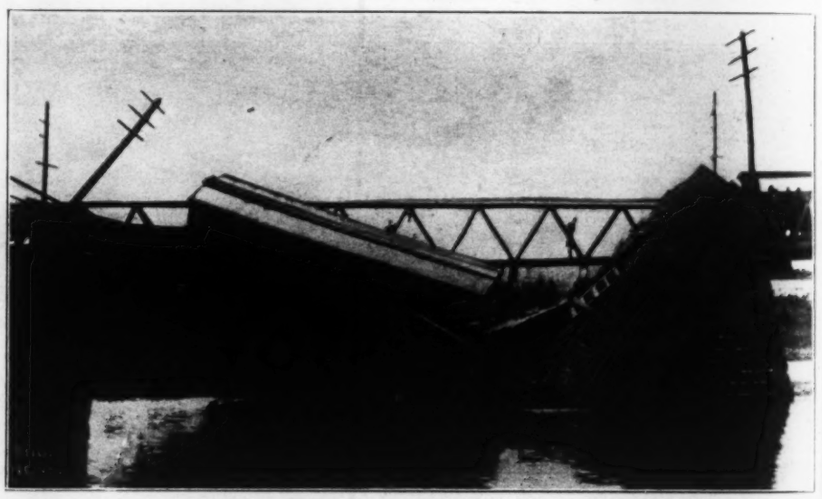
An iron bridge on the Intercolonial Ry. at New Glasgow, N. S., failed under a freight train on Nov. 7. Photographs taken shortly after the wreck by Mr. W. H. Hyde, Assoc. M. Am. Soc. C. E., to whose courtesy we are indebted for copies, are reproduced herewith. The circumstances of the wreck are described as f... by the Halifax "Chronicle" of Nov. 8:

At 2 a. m., Nov. 7, a span of the Intercolonia... bridge at New Glasgow collapsed under the w... freight train, dropping seven cars and the ten... engine into the water of the East River witho... life or injury to the train crew.

The train consisted of engine No. 228 w... Hugh Campbell, seven cars and a van. About ... as they were crossing the iron bridge at New Gl...

a speed of 8 miles, the whole train was on the brid... and the engine was just entering upon the Northern span—that is, the one nearest New Glasgow, when Driver Campbell felt his engine settling down on the right-hand side, and at the same instant the ironwork of the bridge crashed into the cab window on the left. On the instant he gave his engine steam and like a living thing she tore herself out of the yawning chasm. She was thrown off the rails by the weight of her tender hanging down in the river, but broke away and ran on the sleepers to the New Glasgow end of the bridge. The seven cars and the tender of the engine dropped 20 ft. into the river and piling up on top of each other stopped the van in which was the conductor and three brakemen.

The bridge is a lattice girder iron bridge and was made in England 37 years ago. It consists of four 80-ft. spans. It is impossible to say just now what gave way, but apparently the eastern side of the second span from the New Glasgow end broke down somewhere near the stone abutment on which it rested. That part of the span is at the bottom of the East River. The bridge was inspected and strengthened about three years ago.



NEAR VIEW OF WRECKED SPAN.

As seen by the photographs, the bridge was a light riveted pony truss structure of the Warren girder type. As the trusses are apparently held erect by knee braces from the floor beams, it is rather remarkable that when one truss and the floor went down, the other truss did not tip over and go down also. From the photograph one end of this truss appears to have gone over part way, but the other end remained erect.

TOTAL VALUE OF THE MINERAL PRODUCTS OF THE UNITED STATES AT FIVE YEAR PERIODS SINCE 1880.

	1880	1885	1890	1895	1900	1901	1902	1903
Metallic products.....	$190,039,865	$181,586,587	$305,872,422	$281,479,931	$550,425,286	$518,266,259	$642,258,584	$624,318,008
Non-metallic products.....	173,279,135	241,312,093	312,776,503	388,172,239	512,252,767	567,286,035	617,251,154	794,403,561
Unspecified.....	6,000,000	5,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
Total.....	$369,319,000	$427,898,680	$619,648,925	$620,652,170	$1,063,678,053	$1,086,552,294	$1,260,509,738	$1,419,721,569

STATISTICS OF RAILWAYS OF THE UNITED STATES IN 1903.

Advance sheets are at hand of the 37th annual number of "Poor's Manual of the Railroads of the United States," with its usual complete summaries of the financial and other affairs of American railways. The total railway mileage of the United States on Dec. 31, 1903, is given as 207,603, an increase of 4,774 miles during the calendar year. The total track mileage is 286,262. The statistics of operations for the fiscal year are summarized in the accompanying table. It will be noticed that of every dollar earned by the railways, about 22 cts. came from passenger traffic and nearly 70 cts. from freight traffic. In paying out this money the railways paid out of every dollar 69 cts. for operating expenses, 15 cts. for interest on bonds and other debt, and 10 cts. for dividends on stocks.

Table II. gives the track mileage and rolling stock equipment for each year since 1880. It is, perhaps, some index of the longevity of rails that whereas it seems almost certain that practically no new iron rails have been laid for at least 20 years past, there still remain over 15,000 miles of iron rails in service. In the rolling stock figures, a most remarkable feature is that the number of passenger cars is now very little greater than it was in 1893. This is doubtless to be explained chiefly by the inroads made by the electric railways on the suburban and interurban passenger traffic which was formerly wholly dependent on the steam railways. Nevertheless, passenger traffic has greatly increased, as is shown by Table III. The total passenger movement which was about 15 billion passenger miles for 1893, was nearly 21 billion passenger miles in 1903. Moreover, since 1898 a steady increase is shown in rates of passenger fare. This is probably due not to an actual raising of fares, but to the transfer of suburban and commutation passengers who travel at a low rate per mile, to the electric roads.

The increase in freight traffic shown by Table IV., is certainly an amazing showing. From 82 billion ton miles in 1894 the increase has been a rapid one until in 1903 over 171 billion ton miles was the record. This increased traffic, moreover, has been provided for chiefly by increasing the loads carried by each freight locomotive, the table showing about the same freight train mileage in 1903 as in 1898. The average freight train load has increased from 164 tons in 1891 to 313 tons in 1903.

TABLE I.—Statistics of the Operation of United States Railways in the Fiscal Year, 1903.

Miles of Railroad reporting traffic statistics, earnings, etc.			204,725.37		
Miles of Railroad reporting earnings only			511.75		
Total			205,237.12		
Passenger Train Mileage	on 204,725.37 Miles RR.	429,014,116	Passengers Carried	on 204,725.37 Miles RR.	696,927,043
Freight Train Mileage		547,235,409	Passengers—Mileage		20,985,584,855
Mixed Train Mileage		22,205,287	Tons Freight Moved		1,999,694,081
Total Revenue Trains		998,545,812	Tons Fgt. Moved One Mile		171,290,310,085
Earnings—Passenger	on 204,725.37 Miles RR.	$428,723,240	Payments from Available Revenue: Interest on Bonds		$239,426,707
Freight		1,337,706,786	Other Interest		8,680,451
Other		129,956,962	Dividends		164,549,147
Earnings of 511.75 M. RR., Class 4 (see p. IV.)		12,470,838	Rentals—Interest	$38,675,121	
Total Traffic Revenue (205,237.12 miles)		$1,908,857,826	Dividends	26,195,268	
Operating Expenses (205,237.12 miles)		1,316,349,314	Miscellaneous	21,320,540—	86,190,929
			Miscellaneous		61,336,614
Net Earnings (205,237.12 miles)		$592,508,512			
Other Receipts		89,485,484	Total (205,237.12 miles)		$560,113,908
Total Available Revenue (205,237.12 m.)		$681,993,996	Balance—Surplus over fixed charges and miscellaneous payments		$121,880,088

THE CEMENTING POWER OF ROAD MATERIALS.*

By Logan Waller Page† and Allerton S. Cushman.‡

For several years the road material laboratory, now included in the Division of Tests, has been desirous of impressing upon engineers and others interested in road building the importance of that property of road materials known as cementing power and its relation to the selection of the best materials. Every one who has given careful attention to this subject is aware that different rocks vary widely in their binding power. While some broken stones will easily and rapidly consolidate under the roller or traffic, others will do so only slowly and with difficulty, while again some totally lack any binding power whatever. Furthermore, as pointed out in previous publications from this laboratory, the species of the rock is practically no guide as to its road-making quality, and a study of Table III. clearly shows this to be true in regard to cementing value. The cementing power is caused by a hydrated condition of the particles, which is the result of certain secondary changes produced in the minerals composing the rock structure. Whether these changes take place depends upon circumstances, and not, broadly speaking, upon the rock species. The subject, however, will be more fully discussed later on.

The standard fall of the hammer for a cementation test is 1 cm. (0.39 in.) and this blow is repeated until the bond of cementation of the material is destroyed. The blow producing failure is easily ascertained, for when the hammer falls on the plunger, if the material beneath it can withstand the blow it recovers; if not, the plunger stays at the point to which it is driven, and in either case the behavior of the test piece is recorded on a drum. The automatic record thus obtained from each briquette is filed for future reference. The number of blows required to destroy the bond of cementation or resilience, as described above, is noted, and the average obtained upon five briquettes is given as the cementing value.‖

In the earlier practice of the laboratory it was the custom to make a recementation test. The fragments of the briquettes from the cementation test were ground, again mixed with a definite quantity of water and immediately remolded into briquettes. This was done on the theory that the rock dust on a road surface is continually being cemented, broken up, and recemented under traffic. A very large number of tests showed that the recementing values in by far the larger number of cases were smaller than the corresponding cementing values. There were, however, a number of cases in which the reverse took place. This is shown in Table I., in which the cementing and recementing values of a number of rock species are compared:

TABLE I.—Comparison of Cementing and Recementing Values.

Serial No.	Name.	Cementing value.	Recementing value.
335	Diabase (trap)	110	89
336	Ferruginous limestone	158	72
337	Dolomitic limestone	59	42
338	Novaculite (chert)	24	18
340	Limestone	95	20
343	Dolomite	32	23
344	Sandstone	54	23
349	Diabase (trap)	49	44
346	Limestone	8	13
351	Gravel	11	13
383	Limestone	22	34
403	Limestone	110	126
492	Dolomitic limestone	22	30
497	Hornblende schist	7	9

These anomalous results called for a thorough investigation of the whole question. As it is well known in clay working that the soaking and kneading of a clay for protracted periods increases not only the plasticity, but the binding power, it was suspected that the prolonged action of water on fine rock dust might well increase the binding power at least up to some maximum value. Investigations were at once begun to see if the underlying cause of the cementing power could be discovered. Some of the results of this research have already been published* from this laboratory. It is sufficient to say here that the conclusion was reached that the rock powders which have binding power contain a certain proportion of particles which are colloid in their nature. Under the action of water the particles to some extent soften and become adherent. On drying out, this adherent bond locks the particles together. In the case of clays this bond is usually very strong, while with rock dust it is extremely variable, ranging from those which yield briquettes that break on the first blow to those which will sustain hundreds without failure.

After the observations had been made which led to the conclusions outlined above it became evident that a modification was necessary in the manner of making the briquettes for the cementation test. Since the bond is developed under the prolonged action of water, it is manifestly unfair to wet the rock dust and immediately mold the test pieces. Moreover, as the action of water begins at once, and according to the laws of physical chemistry is more rapid at first, slowing down gradually as the point of completion of the reaction is approached, it is apparent that considerable errors in the results may be occasioned by small variations in time after the wetting of the dust takes place until the briquette is molded. It will also be shown that with nearly all materials the amount of working or kneading which is done upon the wet mass will effect the softening of the particles, and hence the strength of the bond. These variations were sufficiently large in some cases to account for the anomalous results in the cementation and recementation tests; hence the recementation tests were immediately given up

*Condensed from Bulletin No. 85, Bureau of Chemistry, U. S. Dept. of Agriculture.

†Chief, Division of Tests, Washington, D. C.

‡Chemist, Division of Tests, Washington, D. C.

‖The Bulletin contains illustrations of the machines used in making and testing briquettes, and text descriptive of their use.

*J. Amer. Chem. Soc., 25:5.

TABLE II.—Track Mileage and Rolling Stock Equipment of United States Railways, 1880-1903.

Year.	Miles Steel Rails.	Miles Iron Rails.	Total Track (Miles).	Per Cent. Steel of Total.	Locomotives	Revenue Cars. Passenger.	Baggage, Mail and Express.	Freight.	Total.
1880	33,680	81,967	115,647	29.1	17,949	12,789	4,786	539,255	556,930
1881	48,984	81,471	130,455	37.5	19,911	13,947	4,976	648,295	667,218
1882	66,611	74,267	140,878	47.3	21,889	14,934	5,564	730,435	750,933
1883	78,411	70,690	149,101	52.6	23,405	16,230	5,848	778,683	800,741
1884	90,102	66,252	156,414	57.6	24,353	16,644	5,911	798,300	820,954
1885	98,013	62,493	160,506	61.0	25,662	16,497	6,044	805,517	828,058
1886	105,630	62,322	167,952	62.9	28,108	18,365	6,325	845,912	870,602
1887	125,949	59,586	184,935	67.8	27,275	19,320	6,554	950,899	976,774
1888	130,398	52,981	191,367	72.3	29,406	20,947	6,827	1,006,108	1,032,182
1889	151,578	50,510	202,088	75.0	30,566	21,471	7,053	1,051,141	1,080,665
1890	167,458	40,694	208,152	80.4	31,812	21,664	7,253	1,061,902	1,090,819
1891	174,775	39,754	214,529	81.5	33,561	23,083	7,366	1,168,679	1,194,130
1892	192,711	38,918	231,629	82.4	34,698	24,604	7,980	1,177,113	1,209,457
1893	190,718	37,130	227,853	83.7	36,118	27,179	7,877	1,206,444	1,241,500
1894	197,491	35,364	232,755	84.9	36,304	26,357	7,921	1,228,781	1,263,059
1895	206,381	28,650	235,031	87.8	36,610	26,419	7,891	1,230,798	1,265,108
1896	210,290	28,440	238,730	88.1	36,398	24,940	7,980	1,245,640	1,278,560
1897	213,656	26,043	241,701	89.2	36,410	23,654	8,180	1,234,972	1,266,806
1898	220,804	24,435	245,239	90.0	36,746	25,844	8,049	1,284,807	1,318,700
1899	228,976	21,387	250,363	91.5	37,945	26,184	8,121	1,328,684	1,362,989
1900	238,464	19,389	257,853	92.4	39,065	26,786	8,309	1,350,258	1,385,353
1901	246,811	19,181	265,992	92.7	39,729	27,144	8,667	1,409,472	1,445,283
1902	257,437	17,398	274,835	93.6	41,626	27,364	9,736	1,503,949	1,541,039
1903	271,013	15,249	286,262	94.6	44,529	28,648	10,182	1,524,150	1,562,980

TABLE III.—Passenger Traffic for 13 years.

Years.	Length of RRs. in Operation.	Miles Run by Passenger Trains.	Passenger Traffic. Pass'ng'rs Carried.	Passenger Movement.	Passenger Earnings. Gross Amount.	Ave. Receipts p. Pass. p. Mile.	Av. Rec. per Pass.	Av. Rec. p. Pass. Train Mile.	Av. Rec. p. Mile of RR.	Ave. No. of Passengers per Mile of Railroad.	Ave. No. of Passengers per Pass. Train Mile.	Average Distance Traveled p. Passenger.
	Miles.	*Miles.*	*No.*	*Miles.*	$	*Cents.*	*Cents.*	*Cents.*	$	*No.*	*Miles.*	*Miles.*
1891	164,382	335,712,013	556,015,809	18,316,925,939	290,799,606	2.184	52.30	90.67	1,770	8,945	41.50	33.95
1892	170,607	343,930,550	575,769,678	18,594,343,304	293,557,476	2.168	50.99	90.08	1,721	3,975	41.93	32.30
1893	175,261	326,851,408	507,056,530	14,979,947,426	310,441,870	2.072	52.00	91.70	1,791	3,444	44.25	25.09
1894	176,251	347,981,880	560,693,216	15,600,581,655	273,354,196	2.025	48.34	84.47	1,563	3,553	41.72	21.67
1895	179,154	326,184,586	549,756,250	16,609,092,681	260,289,741	2.009	49.25	79.99	1,454	3,267	34.66	23.84
1896	180,891	347,641,115	535,130,756	13,054,940,948	266,318,256	2.082	49.56	78.54	1,467	3,258	36.66	21.40
1897	180,621	342,464,408	504,106,305	12,491,956,000	253,557,080	2.029	50.30	74.04	1,403	2,791	36.49	24.78
1898	185,216	344,761,142	514,982,488	13,672,497,664	273,589,591	1.994	52.93	79.37	1,488	2,831	39.08	26.55
1899	193,550	355,108,523	537,377,201	14,668,341,562	297,508,772	2.002	55.31	83.79	1,604	2,822	41.94	27.63
1900	193,694	373,236,561	564,695,295	16,313,394,471	323,402,816	1.981	56.67	86.79	1,738	3,046	43.32	27.90
1901	193,822	391,543,708	600,485,790	17,789,688,925	360,702,699	2.028	60.07	92.12	1,861	3,098	45.43	29.63
1902	196,648	408,913,178	655,130,286	19,708,908,785	394,513,412	2.002	60.52	96.54	2,016	3,381	48.67	30.08
1903	205,910	428,978,156	696,908,924	20,985,573,853	428,713,109	2.052	61.52	99.94	2,102	3,418	48.71	29.98

TABLE IV.—Freight Traffic for 13 years.

Years.	Length of RRs. in Operation.	Miles Run by Freight Trains.	Freight Traffic. Freight Carried.	Freight Movement.	Freight Earnings. Gross Amount.	Av. Receipts p. Ton p. Mile.	Ave. Rec. per Ton.	Av. Re. p. Fre't Train Mile.	Av. Re. per Mile of Rlt.	No. of Tons per Mile of Railroad.	Ave. No. of Tons per Mile Freight Train.	Average Haul per Ton.
	Miles.	*Miles.*	*Tons.*	*Miles.*	$	*Cents.*	*Cents.*	*Cents.*	$	*Tons.*	*Miles.*	*Miles.*
1891	164,382	494,541,369	704,386,909	81,310,154,523	754,185,910	0.929	107.07	152.81	4,591	4,286	164.55	115.49
1892	170,607	523,831,458	730,035,011	84,413,197,130	794,526,500	0.941	108.74	151.67	4,657	4,382	161.14	115.53
1893	175,261	531,340,754	737,464,480	90,552,097,200	808,494,008	0.893	106.74	152.16	4,663	4,369	170.42	119.55
1894	176,251	475,780,985	674,714,747	82,219,940,498	703,477,409	0.864	103.93	147.22	3,975	3,829	172.81	121.86
1895	179,154	497,410,820	753,799,883	88,267,170,801	743,784,451	0.832	97.98	151.36	4,151	4,263	193.23	115.96
1896	180,891	497,348,396	778,868,716	93,836,853,634	770,424,013	0.821	99.53	154.91	4,259	4,378	198.61	121.32
1897	181,065	500,336,373	788,265,448	97,442,569,150	780,351,935	0.797	98.99	157.77	4,310	4,354	195.56	124.22
1898	185,117	542,824,503	912,973,933	114,586,171,191	868,994,526	0.753	95.18	160.09	4,719	4,959	211.06	125.50
1899	186,221	584,391,846	975,780,941	126,974,703,110	922,436,814	0.726	94.53	172.41	4,953	5,240	237.44	130.04
1900	191,455	513,667,398	1,071,431,919	141,162,109,413	1,052,853,811	0.746	98.30	204.95	5,499	5,506	274.79	131.80
1901	194,453	505,468,819	1,094,066,451	148,050,918,499	1,126,987,599	0.756	103.00	222.82	5,792	5,575	294.76	135.41
1902	197,341	509,210,140	1,192,136,510	166,024,161,024	1,197,212,492	0.764	100.43	235.57	6,065	6,041	304.19	131.38
1903	204,608	547,235,409	1,999,694,081	171,290,310,085	1,337,706,610	0.781	102.98	244.41	6,536	6,350	312.96	131.79

as being of no value, and methods were devised by which the cementation test was improved.

The finely ground and sifted rock dusts were mixed with a sufficient quantity of water, and were worked and kneaded until an even consistency of stiff dough was obtained. From these doughs series of briquettes were made at intervals and tested. The effects produced by age on doughs of three typical specimens, including samples of good, medium and poor cementing values, were plotted and studied. This study showed that there is invariably a rapid rise in binding power in the newly made doughs, and that after the lapse of 24 hours the value has, for the purpose of the test, become practically constant. This effect is, of course, more apparent in materials of high cementing value than in lower ones. Numerous experiments have shown that with powders, such as fine sand, which have no particles of a colloid nature, and therefore no binding power, soaking or kneading will not develop the slightest increase. In carrying out the cementation test the doughs are now invariably aged for at least 24 hours, and the workman is trained to knead the dough always in the same manner for about the same length of time. Careful attention to these details has resulted in a great improvement in the value of the test, both in a lessened percentage of variation in different test pieces of the same series, and also in the agreement of the tests with the results of service. The percentage of error from variation is about the same as in cement testing if carried out with the same care.

Several criticisms have been made upon the cementation test, the opinion offered being to the effect that the results are too uncertain to be of value. The persons making these criticisms had not, however, availed themselves of these later improvements in the manner of making the test pieces. On the other hand, it cannot be too strongly urged that the object of the test is to gain information which will be of use to road builders and not merely to accumulate data of abstract interests. Rocks are far from being homogeneous materials, and in addition the cementing power itself is such a variable quantity that it may be said that the test has served its purpose if it does no more than distinguish high binding material from that which is only fair, and this in turn from that which has little or no binding power at all.

We come now to the bearing of the test upon the results of actual service. There have been few instances in the experience of the laboratory where the results actually attained upon the road have not agreed with the results obtained in the laboratory; the few exceptions to this rule occurred before the investigations were completed, the results of which are given in Table II. In many of the Southern and Southwestern states, notably Alabama, occur large deposits of chert and cherty gravels which bind well and make excellent roads. In the laboratory these materials gave low cementing values by the older method of procedure; when, however, the chert dust was soaked and kneaded the binding power rose to the values which would be expected. It is well known in practical road building that some materials which do not consolidate readily do improve with age upon the road, and wet rolling, where possible, is the invariable remedy for the difficulty. The results obtained by the old and new methods are given in Table II.

TABLE II.—Cementing Values of Samples of Chert by the Old and New Methods.

Serial No.	Locality.	Cementing value. Old method.	New method.
338	Graytown, Tenn.	24	240
342	Near Columbia, Tenn.	148	1,083
389	Birmingham, Ala.	10	84
391	do	35	127
392	do	26	113
393	do	6	58
394	do	26	102
388	do	8	31
443	do	118	390
414	Walker County, Ga.	2	12
418	Walker County, Ga.	9	35
438	Hot Springs, Ark.	2	10
538	San Jose, Cal.	9	13
360	Blue Springs, Neb.	17	102
584	Elco, Ill.	4	15
437	Elco, Ill.	12	72

An investigation recently taken up and at present in progress further illustrates the importance of the wet rolling of roads and may ultimately be shown to have a direct bearing on the cementation test. It consists in grinding the material with water in the ball mill and immediately molding it into briquettes. Up to the present time all rocks, even quartzite, show a cementing value, and in almost all cases results are higher than by the dry method. At this writing, however, the number of results is too small to be correlated, and no general conclusions can be drawn. This investigation will be continued and the results reserved for a future publication.

CAUSES OF CEMENTING POWER.

As was outlined in the introduction, the whole question of the binding power of rock dust was early recognized as being closely associated with the same property in clays. In fact, considered from the standpoint of road materials, it is difficult to determine where the classification as clay should stop; that is to say, clays pass imperceptibly into gravels. Some gravels which contain a certain proportion of clay base will be found to bind, while a clean quartz gravel absolutely lacks this property. While this is easily understood, it does not, on first examination, seem to have any bearing upon the great difference in binding power which is exhibited by clean, deep quarried rock. It will be found, however, that the considerations are identical. Clays themselves are the product of rock decay under the action of water and watery solutions. The essential clay base is supposed to be a hydrated silicate of aluminum, known as kaolin, which is the result of the action of water on the double silicates of aluminum and the alkali metals. The most typical of the double silicates are the feldspars, a class of minerals very widely distributed in nature and occurring as a crystalline ingredient of a great number of different rock species. The microscopical analysis of rocks shows that a great many of the minerals which make up the aggregate structure have undergone secondary changes similar to, if not identical with, kaolinization of feldspar. Now, kaolin, as found in nature, although not lacking in binding power, does not, as a rule, excel in this quality. The ball clays are usually added by potters to the purer kaolins and china clays to increase both the plasticity and the binding power. It is very evident that binding power is not due to the presence of a particular mineral such as kaolinite; on the contrary, the higher binding clays show a preponderance of amorphous rather than of crystalline particles.

The evidence obtained in this laboratory points to the following conclusions: Many minerals under the action of water or of watery solutions are decomposed. The secondary products, which are usually highly hydrated, may or may not lead to binding power, as they are capable of existing in allotrophic modifications which differ in this respect. Alumina and many other substances can be easily prepared by wet reactions in the laboratory, either as gummy colloids or as finely crystalline precipitates, by slightly varying the conditions. In nature the conditions are of every possible variety, and thus we find a physical property like cementing power varying through wide limits in those rock species which exhibit it. In a word, those rock dusts which contain a certain proportion of particles which on soaking with water soften to the extent that they become, to ever so slight a degree, glue-like (colloid), and thus adhere, are those which are useful to the road builder. Many of the traps, limestones and sandstones, fall under this head. Those rocks, on the other hand, which are of an entirely unaltered crystalline structure, or those which, through metamorphic changes—heat and pressure—have had the active hydrated particles destroyed—such as slates and quartzites—should be avoided on the surface portion of the road.

These conclusions are borne out in service where the problem has to be solved of building roads of material which, while hard enough to bear traffic, is without binding power. A good example is furnished by the excellent sand-clay roads in the Southern states, described in the Yearbook of the Department of Agriculture for 1903. A somewhat similar case is that of burnt-clay roads, which have been advocated by this laboratory for several years and upon which experiments are now being made. Clay itself, as every one knows, is generally too soft and plastic to bear traffic in wet weather, although its binding power is high. By burning and clinkering a portion of the clay to be used on the road its hardness is increased and its binding power destroyed. By proper constructive methods and mixing we approach the conditions obtained with rock dust and with sand-clay mixtures.

It may be objected that at least one exception to the general rule is furnished by certain furnace slags which certainly have not undergone secondary changes, and yet have been successfully used on roads in some localities. This subject has been especially investigated, and it has been found that siliceous slags are in no case suitable for a binder surface. Certain basic slags, which have an excess of lime in their composition, and which have been quickly cooled at the furnace, make an excellent material for light-traffic roads, as the slag dust takes on an actual mild set similar to that of Portland cement. Doughs made of such slag dust set hard before they can be aged 24 hours preparatory to molding the test pieces. It is apparent that this special case of slags has no general bearing upon the conclusions reached.

It happens that certain ferruginous limestones and gravels bind exceedingly well, and this has led to an erroneous impression, which prevails even among engineers of long experience, that "iron" is the cause of the bond of cementation. Broadly speaking this is not true, for many of the highly ferruginous red sandstones do not bind. A series of experiments was made in the laboratory to determine whether iron ores, such as hematite and the hydrated oxid, limonite, possessed cementing power, and it was found that exceedingly pure limonite had a low value and hematite none at all. If, however, there were siliceous or clayey impurities present, the values would be much higher. It has been frequently observed that when metallic iron filings—as, for instance, in the neighborhood of a machine shop—are thrown upon a footpath, the path consolidates into a hard impervious shell under the light impact of human feet. This bond may be due to the mere rusting together of the iron particles, or it is possible that hydroxid of iron, which is formed under the influence of water and oxygen, is colloid in its nature, and thus acts as an ordinary binder. If hydroxid of iron is precipitated by the wet method in the laboratory and the resulting colloid precipitate after partial drying out is mixed with material like fine sand or ground glass, the hydr drying will bind the particles together. In the sa it is possible to prepare in the laboratory colloid tions of alumina, silica, and various silicates, those of aluminum, calcium, iron, and magnesiu these substances appear in rock structures, gravels and soils, and all of them were found to act to a or less degree as binders when tested in the labora

Whenever a clay of high binding power is heate red heat, its binding power, together with the abs porous structure which is characteristic of the col totally destroyed. This is equally true of these ar preparations and of high-binding rock dust. It is im ble not to conclude that the same structure is pres all three cases.

Those who are interested in a scientific study of materials will undoubtedly acknowledge the importan understanding the fundamental causes of all the qualities these materials possess. It is natural, how that the average man should desire more particularly information as will enable him to select the best ma for his purpose. If the actual results of service hav already been determined there is no alternative but a peal to the testing laboratory. A study of Table III. show that cementing value is not confined to any par lar species of rock. The highest trap tested amon large number of samples had a cementing value of the lowest a value of 1. In the same way the limesto will be found varying from 231 to 4.

TABLE III.—Range of Cementing Value in Different Rock Species.

Kind of rock.	Number of samples.	Maximum.	Minimum.	Average
Amphibolite	8	36	3	10
Andesite	3	337	14	129
Basalt (trap)	22	500	2	91
Chert	19	500	2	101
Conglomerate	3	327	12	154
Dolomite	20	161	2	31
Diabase (trap)	39	110	2	26
Diorite (trap)	13	137	1	20
Eclogite	5	20	1	7
Felsite	7	101	2	34
Flint	1	31	31	31
Gabbro	8	131	3	30
Gneiss	22	21	1	6
Granite	37	77	1	10
Pyroxene granulite	1	1	1	1
Limestone	77	231	4	63
Marble	1	5	5	5
Peridotite	1	3	3	3
Quartzite	10	9	1	4
Rhyolite	9	500	1	152
Sandstone	26	323	1	63
Schist	25	272	1	23
Shale	3	500	62	314
Slate	2	202	151	176
Syenite	2	11	2	7

Considering only the crystalline rocks and excluding clays and gravels, Table IV. [Not reprinted.] given at the close of the report, reveals a decided tendency toward high-binding rocks in certain sections of the country and to exceedingly low ones in others. The amount of data so far collected does not as yet justify a definite conclusion being drawn on this point, but it is highly significant that in one state, out of some 30 samples tested, not one had a higher value than 10, while in another state, out of an equal number of samples, only 1 fell below that figure. It is perhaps too soon to say that these results are not fortuitous, but it is quite apparent that in those localities where good road materials are abundant good roads will be found, and it is a fact that the samples which are sent to the laboratory from the two states noted for having the best roads and greatest mileage represent almost invariably high-binding materials. It is evident that the possession of good road materials will stimulate their use, whereas the discouraging results of failure in less-favored communities will keep the people shut in by mud and ruts for much longer periods. This point of geographical distribution, which perhaps has never been brought out before these investigations were instituted, is sufficient to justify and encourage all scientific study of road materials. Undoubtedly what is needed is more data, much more indeed than can be supplied by one laboratory, however complete its equipment. State laboratories under the direction of or in collaboration with the state highway commissioners would soon accumulate data which would make possible road material maps giving all the physical data in as accurate a manner as possible. Before, however, such cooperation can be of the slightest value, the methods of testing must be standardized so that all results may be comparable. To this end the writers in 1903 urged the American society for testing materials to appoint a committee to consider the whole subject and report on standard methods. This committee has been appointed and is at work with every prospect of arriving at a successful conclusion.

One great obstacle to the growth of road material testing is the cost of the machines. An important problem which is engaging the attention not only of this laboratory, but also that of the Maryland geological survey, is the simplification of the various tests, and more particularly of the various machines necessary, so that the cost of equipment of a road material laboratory shall be brought within the means of all.

SEWAGE TREATMENT IN THE MERSEY AND IRWELL DRAINAGE AREAS, ENGLAND.

An idea of the extent to which sewage treatment has been carried in some of the densely populated sections of Great Britain can be obtained from the last report of Mr. R. A. Tatton, Assoc. Inst. C. E., of Manchester, England, Chief Inspector of the Mersey & Irwell Joint Committee. This committee has jurisdiction of the section of country embracing Manchester and vicinity, and including the drainage areas of the rivers Irwell, Roch, Irk, Medlock and Mersey, and also the waters of the Manchester Ship Canal. There are 96 municipalities within the borough, divided as follows in numbers and population: 7 county boroughs with 1,324,964 population; 14 non-county boroughs, 389,984; 63 urban district councils, 690,286; 11 rural district councils, 96,869; total population, 2,502,103.

In May of the present year 80 of the 84 urban authorities and 10 of the 11 rural authorities had works in operation for treating the sewage, while of the four urban authorities without works one had submitted plans to the Local Government Board, and another had a scheme under consideration. Twelve years earlier, or in May, 1892, there were 76 urban authorities under the jurisdiction of the committee, of which only 27 had works in operation, 8 had works under construction, 15 had schemes in various stages and 26 had neither works nor schemes.

Of 444 manufactories in the district, not connected with municipal sewerage systems, all but five have sewage works. Of the 339 works, Mr. Tatton lists 306 as efficient and 133 as not efficient, but he states that of the latter many have surroundings too limited to permit the construction of efficient plants.

The 444 manufactories include 120 dye works, 75 bleach works, 48 print works, 59 woolen trades works and 26 paper works, besides tanners and leather dressers, fellmongers, stone polishers, chemical works and others.

An encouraging feature of the inspection work is that the rivers are becoming more usable by the manufacturers, thus gradually winning the latter over to the side of the committee. No legal proceedings against manufacturers have been taken for the past six years, but several manufacturers have been summoned to show cause why proceedings should not be taken. This method may seem to be a slow one, but, on the whole, it results in considerable progress with comparatively little friction.

The report includes tabular descriptions of the municipal sewage works in the district, from which it appears that chemical precipitation is still used for preliminary treatment at many of the works, and that various methods of final treatment are employed.

SANITARY REGULATIONS FOR WORKMEN'S camps on the water power extension of the Chicago Drainage Canal, between Lockport and Joliet, Ill., are substantially as follows:

A sanitary inspector, appointed by the board, shall make thorough inspection of the camps, the food, water, bedding, etc., at least once a week or oftener if required by the board.

The man in charge of the boarding camps must furnish food and bedding satisfactory to the board of trustees and it shall be the duty of the inspector to condemn all food or other supplies unfit for use.

Garbage and refuse must be removed from the habitations daily, and the eating and sleeping quarters shall be thoroughly cleaned at least once every 24 hours.

The water supply shall be periodically examined, and in cases of sickness patients shall receive prompt treatment and be removed from the premises at once if there is any danger of contagion.

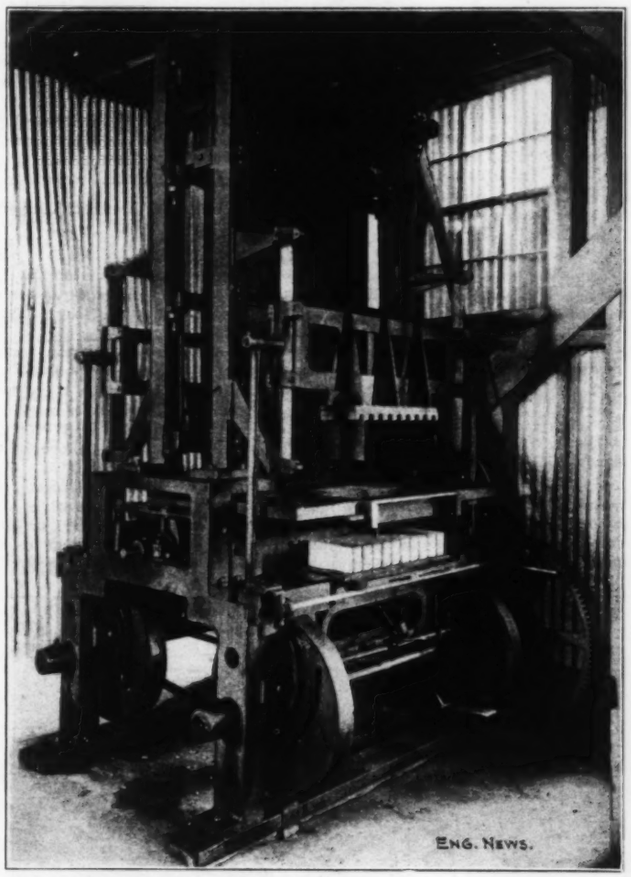
Ventilation shall be looked out for and any violation of these conditions shall result in the immediate discharge of the contractor in charge of the boarding privilege.

Prior to the agitation which led to the recent adoption of these regulations the contractor's camps, it is reported, were in so bad a condition that workmen would quit after a short term of service.

THE MERRILL DAM HAS BEEN COMPLETED across the Ohio River three miles below Beaver, Pa. This dam is one of a series of similar structures for developing slackwater navigation in the upper Ohio River. The dam was built by government work and by contract at a cost of $1,000,000. Work was begun on the lock in the spring of 1892, but the lock was not completed till June, 1897. Then a law was passed by Congress that the work must be completed by contract. The work of building the dam and bear traps was let to a Pittsburg contracting firm, which failed after building 500 ft. of the dam. The rest of the work was awarded in two sections, one for building the 100 ft. of the dam remaining to be built, and the other for the bear traps. The bear traps are the largest in the world. There are two of them, each 120 ft. long and 13 ft. high.

A NEW MACHINE FOR MOLDING CEMENT AND SAND BRICKS.

The accompanying illustration shows a machine which is now being marketed by the Cement Products Co., of Wilmington, Del., for molding cement-sand bricks and concrete blocks. This machine mixes the material and molds the bricks entirely by power; its capacity is stated to be 3,000 standard size bricks per hour. In the illustration only the lower portion of the apparatus is shown, the mixing apparatus being located on the floor above and some feet higher than the bed or platen of the molding box. The complete plant as installed at the works of the builders at Wilmington, Del., may be described as follows:



MACHINE FOR MOLDING CEMENT-SAND BRICKS.
The Cement Products Co., Wilmington, Del., Builders.

The sand and cement are fed from bins by screw conveyors to a mixer, consisting simply of a cylinder set at a slight inclination from the horizontal. This cylinder is without interior fins or other agitating devices, but is slowly rotated by proper mechanism. The cement and sand are fed dry into the higher end of the cylinder and in predetermined proportions, which are kept exact by an automatic measuring device connected with the feed screw. During the first part of their journey through the cylinder the two materials are mixed dry, then water is added, and the material is mixed wet for the remainder of the journey.

The wet mixture drops from the lower end of the cylinder into a hollow column of rectangular shape. The free drop of the material is about 15 ft., and this fall is depended upon to compact the mortar, and, in fact, does compact it so that, it is stated, the water appears at the top. A further working or kneading is given to the mortar within the column by means of the following arrangement: Two sides of the column are fitted closely to the other two sides, and are given a slow reciprocating movement. In addition the column is made slightly tapering toward the bottom.

At the bottom of the column there is a sliding table in which are two compartments or molds of the exact size of the bottom of the hollow column. In operation this table is pushed forward until one mold registers with the hollow column and is filled with mortar. It is then pulled back until the first mold is clear of the column and the second mold is brought into position to be filled. As the first mold becomes clear, a set of knives are pressed down into its contents, dividing the rectangular mass of mortar into bricks. The detachable bottom or platen of the mold is then dropped vertically, sliding the bricks clear of the sides of the molds. The platen with its burden of bricks is then slid onto a conveyor and carried to some convenient point, where it is lifted and set aside until the bricks have become sufficiently set to allow of there being stacked up to harden. The return of the first mold to position under the column clears the second mold, whose contents are divided into bricks and removed for hardening exactly as were the contents of the first mold. The illustration of the machine shows clearly the mold, the knives for cutting the brick and the platen, with its load of brick, dropped ready for removal. The equipment of the opposite side of the machine is exactly similar. For making building brick, the mold is 8¾ ins. wide, 4 ins. deep and 20 ins. long and there are eight blades to the knife, spaced 2 ins. apart. Ten bricks are thus made at each operation.

The proportions of sand and cement for making brick are, of course, varied to suit the conditions, but the company named above has found that a mixture of one part cement to eight or ten parts sand gives a sound and strong material. The advantages claimed for the machine are that it compacts the mortar by a tamping and kneading operation and not by direct pressure; that is, it preserves the principles of mixing and compacting mortar and concrete that are recognized by engineers in ordinary construction work.

THE BAIKAL LAKE SECTION OF THE SIBERIAN RAILWAY.

The route of the Siberian Railway was originally laid out to pass the south of Lake Baikal, but on account of the difficult and expensive work required for the short section of the line near the lake, the railway was built to the shores of the lake, the steamers were put in service to carry the cars across. During the depth of winter trains have been run on a track laid upon the ice, but the crossing has been attended with difficulty and danger during the early and late periods of the winter. Since the opening of the railway attention has therefore been given to this connecting link, which has recently been opened for military traffic, thus avoiding the delay incident to the 45 miles of steam ferry. The new line runs from

the Baikal station on the western division to Myssowosk on the eastern division, a total distance of 161 miles. It is divided into sections, 53 miles from Baikal to Kultuk and 108 miles from Kultuk to Myssowosk. On the latter is a two-mile branch from Tanchoi to a new landing for the ferry steamers.

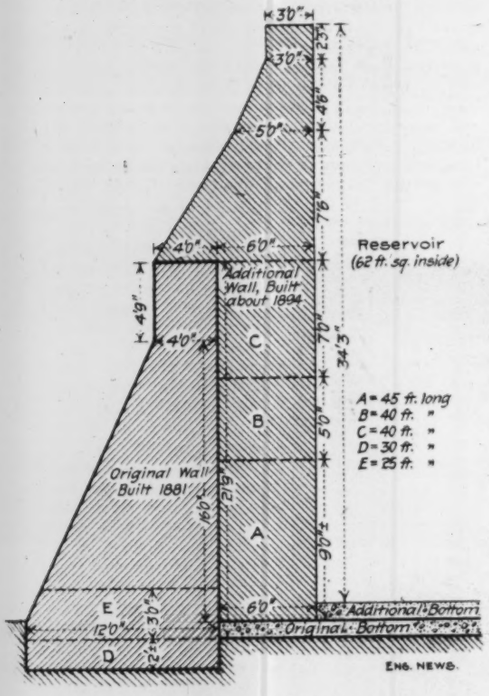


Fig. 1. Approximate Section of Brick Wall of Reservoir at Winston, N. C.

The first section, in the immediate vicinity of the lake, passes through a mountainous country, with deep gorges and almost vertical cliffs. It comprises 32 tunnels, with an aggregate length of 3¾ miles; the longest tunnel is 2,624 ft., and nearly all are lined with masonry. There are also 210 bridges, small viaducts and other works. Many of the cuts are very deep, but as numerous slides have occurred it has been decided to cover in the line in dangerous places. The track is at an elevation of about 30 ft. above the water level. The second section, 108 miles, is farther from the lake and passes through a rolling country; only one tunnel (260 ft.) is required, but the line has to cross a number of torrents, marshes, sliding lands, and some land which is always frozen.

The total cost of the line was about $30,000,000, or $186,300 per mile. The preliminary studies and the geological investigations since 1895 have cost over $540,000. The width at subgrade is 18 ft. on banks and 17 ft. 6 ins. in cuts. The sharpest curves are of 1,050 ft. radius, and the maximum grades are 0.8 per cent. The track is laid with T-rails weighing 64 lbs. per yd. The stations are of timber construction, except for a brick station at Kultuk, and all the engine houses and shops are of brick. The bridges have steel spans on masonry piers, and the viaducts are of masonry. At intervals of 7¼ miles there are turnouts and passing sidings. The tunnels are built large enough for double track, but only one track is laid as yet. The line has a capacity for 14 trains per 24 hours in both directions. Construction was commenced in the spring of 1903, and was intended to be completed early in 1905, but the military necessity for this line has led to the work being pushed during the past few months, so that it was opened for a limited traffic in October, 1904. The section of the line from Tanchoi to Myssowosk (43½ miles) was completed last year.

THE FAILURE OF A SMALL BRICK RESERVOIR AT WINSTON, N. C.

By J. L. Ludlow,* M. Am. Soc. C. E.

The water-works reservoir at Winston, N. C., failed about 5 a. m., Nov. 2, wrecking a number of houses close by it and causing the loss of nine lives.

The structure was a small distributing reservoir, built on the top of a hill, away from all habitations when built, but has since been surrounded by a large number of small residences. Its use as a distributing reservoir was to have been discontinued in a very short time, on account of a stand-pipe that is just being completed. The reservoir was 62 ft. square on the inside and 35 ft. deep, measured from the top of the walls.

The original reservoir was built in 1881 or 1882 by the Winston Water Co. I am informed by the gentleman who was president of the company at that time that it was built after plans prepared by a Mr. Andrews, an engineer who was then employed on a railroad projected through this country. The walls (Fig. 1) were of brick, laid in cement mortar. The foundations of the walls appear to have been set on good stiff clay. In some places the clay was not very deep. The failure a portion of the foundation of the original reservoir was pulled up and overturned with the wall.

About ten years ago the height of the reservoir walls was increased 13⅛ ft. by adding brick work, also laid in cement mortar. This enlargement was made by the city, which bought the works in October, 1894. Mr. J. O. Magruder was city engineer and Superintendent of Water-Works at the time, but I am not definitely advised who recommended the increased height and prepared the plans.

In the failure the entire wall on one side was overturned, breaking off quite clean at the corners, the masonry being broken up into irregular-sized masses of from 125 cu. yds. down.

The wreckage indicates that no effort was made to tie the new work into the old, and that there was little or no bond between the original and new masonry. The position of large pieces of the wrecked masonry indicates that the original part of the wall near the center was overturned first, carrying the top of the new wall with it.

I am unable to find any record of plans and sections after which either the original or the additional portion of the walls was built, but from measurements taken since the failure the enclosed section (Fig. 1) has been drawn. The dimensions and shape given are approximately correct. It appears that the inside or newer portion of the wall was simply set on the brick and cement bottom of the original reservoir, and that little or no bond was made between.

It is interesting to note the position of the masses of masonry since the failure, and this is shown on the section and photograph, Figs. 1 and 2, the corresponding letters showing the location of the particular pieces of masonry when standing in the wall, and the position since the failure. The pieces marked A, B and C are parts of the newer wall, and D and E are parts of the bottom portion of the original wall. It will be observed that the mass A has been overturned and fallen in behind D and E. The masses A, B and C are each 40 to 45 ft. long, and D and E about 30 ft. long. The pieces B and C are completely turned over, the inside faces as they stood in the wall lie facing the opposite direction in the wreckage.

Later.—Replying to your further inquiries, the small rods shown in the view (Fig. 2), are ½ × 1½-in. flats, which appear to have spanned each corner of the reservoir and extended into the masonry about 6 ft. They were probably put there with the thought that in some way they would reinforce and strengthen the corners. I think there were about fifteen or twenty of these rods at each corner of the reservoir. About 4 ins. of the ends were bent around behind the new wall, and most of these broke at the bend and pulled out when the masonry was overturned. I do not think the rods extended into the old masonry, but were simply put in the new masonry when the reservoir was increased in height.

Replying to your second inquiry, it is difficult to find out just what the nominal depth in the reservoir was and what it was at the time of the failure, but I think it has been customary not to keep the reservoir full owing to the leakage that developed in the walls from time to time. There are reports that on the night of the failure the reservoir was practically filled to overflowing, but as to this there appears to be more or less uncertainty.

Replying to your third inquiry, I have understood that from time to time there was some leakage from the reservoir which appeared in the cellar of an adjoining house, which, by the way, was destroyed in the failure of the reservoir, and the occupant had sued the city for damages on account of it, and recovered judgment for a nominal amount which the court decreed to cover all past and future damages from that cause. It hardly appears that the leakage had much, if anything, to do with the failure of the reservoir, as the clay foundation beneath the wall which appears to have failed first was very dry and firm and gave no appearance of having been so saturated that the wall could have settled by reason of the leakage. I do not know how serious this leakage was, except from hearsay.

FIG. 2. VIEW OF WRECKED WALL OF RESERVOIR AT WINSTON, N. C.

*Consulting Municipal, Sanitary and Hydraulic Engineer, Winston-Salem, N. C.

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As many of our readers will remember, Engineering News has always maintained a very conservative position toward the propositions, of which much has been heard during the past few years, for the electric smelting of iron ore. We showed in our issue of May 2, 1901, and again in our issue of Jan. 8, 1903, that the amount of pig iron which it would be possible to reduce from its ore by an electric furnace operating with theoretical perfection, is so small in proportion to the electric power required that only under extraordinary and unusual conditions could an electric smelting process have any hope of commercial success.

A year ago the Canadian Government appointed an expert commission to make an investigation of the whole subject of electric iron smelting to determine whether it was commercially available for the exploiting of Canada's iron ore deposits. The Commission was made up of Dr. Eugene Haanel, Superintendent of the Dominion Mining Department; Thomas Cote, Asst. Census Commissioner; C. E. Brown, of Peterborough, Ont., electrical engineer, and F. W. Harbord, an English metallurgical expert, as Consulting Engineer. This commission visited the principal electric iron smelting furnaces in Europe and has prepared an elaborate report which has just been issued by the Canadian Department of Mines, and forms a volume of over 200 pages. The most important conclusion of the report can be given, however, in very brief compass. It is that:

> Pig iron can be produced on a commercial scale, at a price to compete with the blast furnace, only when electric energy is very cheap and fuel very dear. On the basis taken in this report, with electric energy at $10 per electric horse-power year and coke at $7 per ton, the cost of production is approximately the same as the cost of producing pig iron in a modern blast furnace.
>
> Under ordinary conditions, where blast furnaces are an established industry, electric smelting cannot compete; but in special cases, where ample water power is available and blast furnace coke is not readily obtainable, electric smelting may be commercially successful.

It is also stated that while the expense of the electric process will prevent it from competing with the Bessemer or open-hearth processes in the manufacture of ordinary steel, for the production of high grade crucible steel the electric process is already in commercially successful use.

These conclusions are in accord with those which have been expressed in the editorial columns of this journal, and should be of much service in protecting investors from losing money in wild-cat schemes for electric iron production.

It may be said that this report still leaves open a chance for profitable iron production by electricity in regions having great amounts of water power and iron ore, but remote from coal mines; but those asked to invest in any such enterprise should study closely the cost figures submitted. In a region so remote from commercial centers that coke costs upward of $7 per ton, it will be found, usually, that the cost of installation, operation and maintenance of an electric water-power plant will be largely increased over the cost in more central localities.

One should be very careful, also, in accepting figures for the cost of water power per horsepower annum based on contract figures made by some existing plants. It is a fact that water-power electric plants have been built where no market for the power was in sight, and have been compelled to sell current at a price which gave a very inadequate return on the investment in the plant, as well as insufficient allowance for its maintenance and depreciation.

While it is customary to pay for railroad excavation by the cubic yard measured in place, it is the usual practice to pay for levee or dike work by the cubic yard measured in the compacted embankment. Specification clauses governing the measurement of a dike or levee are not always clear, because there is usually inserted a provision to cover shrinkage. The following clause, however, is exceptionally clear:

> To provide for shrinkage or settling, all parts of the crown and slopes of the levee will be built to a gross height exceeding the final or net height by an amount depending on the method of construction. For such stations of 100 ft. in length of the levee as are put up entirely with teams and scrapers and all parts of which are thoroughly compacted by travel of the teams, and for such stations as may be thoroughly tamped by other means, the required gross height shall exceed the net height by one-eighth the net height. For stations otherwise constructed, the required gross height shall exceed the net height by one-fifth the net height. No payment will be made for the additional earth placed in the levee to provide for shrinkage or settlement.

The feature of this clause to which particular attention is called is the first sentence in which it is distinctly stated that the slopes as well as the crown of the levee shall be built up to allow for shrinkage. Specifications for dikes are often ambiguous in that they simply state a required increase in height of the dike to allow for shrinkage, which leaves it open to conjecture whether or not the slopes must be given the increased shrinkage height. To illustrate the point, assume an embankment that is to have a neat measurement (after shrinkage) of 10 ft. in height, 9 ft. top width, and 44 ft. base width. Such an embankment will contain 982 cu. yds. per station. If it is built 10% higher on the slopes and on the crown, to allow for shrinkage, the contractor will have to put in 98.2 cu. yds. extra; but if he were required to add 10% in height only to the top or crown, and none to the slopes, he would have to put in 33⅓ cu. yds. extra per station—a difference of 65 cu. yds. per station depending upon the interpretation of the specification.

The steel trackway on Murray St., in New York City, which was laid in 1902 by a company of which Gen. Roy Stone was President, has been removed and the street is being repaved with wood blocks by the U. S. Wood Preserving Co.

The steel trackway was described and illustrated in our issue of Dec. 4, 1902. It consisted of a pair of 12-in. channels laid in the pavement with their flanges down and their upper face flush with the surface. The space beneath the channels was filled solid with broken stone resting on a telford bottom and surfaced with gravel.

The length of trackway laid was only about 400 ft., a distance so short that truckmen passing up or down the street seldom took the trouble to follow it, particularly as the street was often, during business hours, partially obstructed by trucks loading or unloading at the curb. Thus the trackway has never served any useful purposes, and from this point of view, the test can hardly be considered a fair one. On the other hand, the advantage of laying such a trackway in a paved street has never been apparent. So far as reduction in traction resistance is concerned, the tests made by Prof. I. O. Baker some years ago showed that the resistance to traction per ton of a wheel rolling on a rail which is covered with dirt or mud, as any rail laid in a street is certain to be covered, is not very different from the resistance to traction offered by a good pavement.

The only other object for placing such a rail in a street surface would be to reduce the wear on the pavement; but here again the concentration of wear from the horses' feet between the lines of rail would probably make such a pavement require renewal as soon or sooner than a pavement in which no rails were laid.

While the advantages of the system appear to be nil, there is positive and strong objection to it on account of horses slipping on its surface. There appears to be no prospect, therefore, that the experiment on Murray St. will be anywhere imitated. The only possible place where such a system might be useful would be on an earth or macadam country road over which very heavy traffic moved. Here, however, the cost of the system is a serious obstacle to its use. We estimated the cost in our article two years ago at not less than $7,500 per mile of single track; and if the traffic were heavy enough to justify such an investment, it would be so heavy that a double track instead of single track would be necessary, or teams would be continually compelled to pass off and on the rails to pass each other.

To sum up, then, the system appears either on a city pavement or a country road to offer no advantages over the ordinary systems of road paving at all commensurate with its cost of construction.

The lease of the Philadelphia gas works to the United Gas Improvement Co., a few years ago, is frequently attributed to the previous failure of municipal ownership. We have always regarded it, instead, as a surrender of the interests of the city after the works had been deliberately wrecked for the purpose of blinding the public to the advantage of retaining the works under municipal control. However that may be, some light upon the kind of a bargain the city then made is thrown by the following note, taken from the "Progressive Age" of Nov. 1, 1904:

> There has been no little misapprehension as to the status of the lease of the Philadelphia gas works. It does not expire in 1908, nor does the United Gas Improvement Co. have to initiate any move at that time. The city has the option of terminating the lease by the payment of all the money spent during the ten years that the gas company will have been in possession, plus 6 per cent. compound interest. It has been estimated that this would be much more than $20,000,000. This would mean that the stockholders would get 6 per cent. interest compounded on an investment upon which they have already drawn 8 per cent. per annum.

It is interesting to know that the lessee does not "have to initiate any move" in 1908. That is left for the city, and if the city resumes control of its property then, according to the journal quoted, it must pay for the improvements made, plus 6 per cent. compound interest, regardless of the fact that the company have already received regular annual dividends upon this investment. We do not pretend to say how much the city is being benefited or otherwise by the change to private operation, but it would appear evident enough that the company drove a fine bargain for its stockholders and one under which the longer it runs the greater the price the city will have to pay for regaining possession of its works.

Among the distinguished English engineers who have just visited this country with the Iron & Steel Institute, there were a considerable number who took part in the previous excursion of the Institute to the United States fourteen years ago, in the fall of 1890. Perhaps the most widely-known engineer among the visitors of 1890, however, was this year numbered among the absent. We refer to Sir Lowthian Bell, Past-President of the Institute, one of its Bessemer Medallists, and among the most widely-known metallurgists of

the world during his years of active life. At the time of his visit to the country with the Institute in 1890 Sir Lowthian was a man of advanced age, being then nearly 75 years old. The American engineers who had the opportunity of meeting him then will be interested to know that although he is now nearly 89 years old, he is still living and still retains such vigor and activity that he has just been elected to the Presidency of the Institution of Mining Engineers of Great Britain.

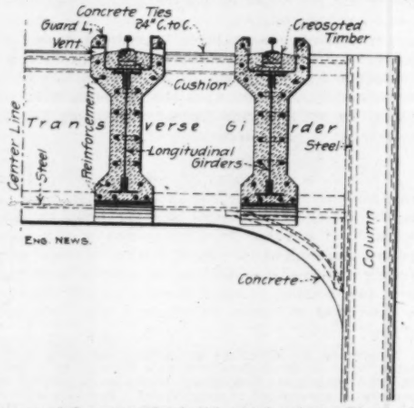
CONCERNING NOISE IN THE OPERATION OF ELLVATED RAILWAYS.

Wherever elevated railways have been operated in city streets, more or less public complaint has arisen on account of the noise produced. When the first elevated railways, those in New York City, were first opened for traffic, there was a great public outcry because of their noise, and so much public opposition was aroused that it became a serious question whether the continued operation of the roads would be permitted. After some weeks of operation, however, it was found that the noise became very much less on account of the fact that the rail heads became worn smooth; and the public opposition ceased.

When it was first proposed to apply electricity to the operation of elevated railway trains, one argument in its favor was that the noise would be reduced. It cannot be said that this expectation has been fulfilled. The noise of the locomotive exhaust has been obviated; but this was never seriously objectionable on elevated railway locomotives; and this reduction in noise is more than offset by the noise of the electric air pumps which supply the brake system. The higher speed at which the trains are run makes the electric elevated trains more noisy on the whole than the steam trains which they replaced.

In Chicago, recently, there has been considerable agitation concerning the noise made by the elevated railway trains in passing over the loop terminal line in the downtown business district. A public inquiry upon the matter was recently held and a plan for reducing the noise was submitted by Mr. J. B. Strauss, Consulting Engineer. This plan was substantially to encase the steel structure in concrete, and to lay the rails on longitudinal timbers in concrete troughs, with a cushion of sand or asphalt between the timber and the concrete. The proposed construction is shown in the accompanying cut, and we quote the following from a statement prepared by Mr. Strauss:

> In the existing types of elevated railway structures, the material throughout is steel, which is probably the best sounding medium in common use. When loaded the steel is stressed and its sensitiveness to sound therefore increased, just like a pianoforte wire which is tuned by stretching. The stringers and cross girders are examples of ordinary transverse sound vibration and the posts, which are rigidly fixed at the level of the ground with tops oscillating under the tractive force of the car, may be likened to a series of huge tuning forks.
>
> There are likewise other causes which contribute to the general noise, such as yielding and uneven rail joints and the lateral scraping of the wheels on the rails. Also the open running gear of the cars and the various defects in the rolling stock generally.
>
> It is clear, therefore, that the noise of the Union Loop exists because noise-prevention has not entered into the calculations of the designers, owners and operators of this or of any other elevated railway system in this country. But the science of engineering is fully equal to the task of effecting a practical elimination of this noise, once the necessity of doing so has been finally established. The most essential change is the conversion of the structure from an elastic to an inelastic structure, as far as possible. After that an increase in its mass to obtain a corresponding increase in its rigidity. In addition a continuous cushioned support for the rails to check the spread of the molecular disturbances at its source.
>
> The most available inelastic material for the purpose is concrete. The velocity of sound in solid granite is 1,661 ft. per second, and in concrete it is undoubtedly a great deal less. The molecular disturbance in the concrete, or, as we may style it, the sound capacity of concrete, is less than one-tenth that of steel. If, then, we encase the structure in concrete we restrict the sound waves to an inferior sonorous body and also largely prevent them from reaching the steel. Whatever does succeed in getting through is immaterial, since the concrete casing prevents the transmission of the sound waves to the air. We also decrease the distance of the sounding body from the ear, reduce the unit stress on the steel, and by adding to the mass of the structure increase its general rigidity, in each of these particulars reducing the volume of noise.
>
> Following the reasoning previously stated, it is still necessary to check the molecular disturbance at its source. This is effected by making fewer rail joints, by giving the rails a uniform and continuous bearing upon longitudinal timbers, and supporting these on cushions of sand or asphalted felt interposed between the timber sleepers and the concrete. This detail insures even rail bearing throughout, makes smoother riding, reduces the noise of contact with the rail, and by reason of the numerous transition surfaces largely prevents the sound diffusion at this point.
>
> It is unnecessary and undesirable to encase the entire structure. The simplest procedure is the separate encasement of stringers, cross-girders and posts, as shown in the accompanying cut. In executing this plan, the present ties and guard rails are removed, and the rails placed in trough-shaped sections, formed in the stringer casings at the top flange. In the bottom of the trough is placed a 2-in. layer of asphalted felt and upon this a creosoted timber spiking piece, to which the rails are secured in the usual manner. The side walls of the trough act as guard rails and are faced with angle irons riveted to U-straps imbedded in the concrete and passing under the rails. Between the ties these walls are provided with vents for the discharge of snow, dirt or other obstructions. At switches the guard rails are diverted in the usual manner, and at both switches and curves the concrete-steel ties are supplemented by a solid floor to carry the rails between stringers.
>
> The concrete casings of each pair of stringers are united by concrete-steel ties which hold the tracks laterally. Casings of cross-girders are uniform throughout and that of the posts is brought almost flush with the foundation footings. All casings are reinforced by steel wire network and in the girders by additional steel bars imbedded in the bottom flange to take the stress due to the weight of the added concrete.
>
> It is proposed to maintain traffic on one-half of the structure while the other half is being reconstructed. This will be facilitated by a special facing for the concrete which will permit it to set under vibration. After the setting has taken place the vibration of the structure will be greatly reduced and will have no further effect on the concrete. Similarly the expansion of the imbedded metal will be very much less than it is at present and can be readily provided for.
>
> The solid floor construction heretofore employed as a sound deadener is imperfect for the reason that the steel girders and posts are free to receive and transmit whatever sound is communicated to them to the enclosed air spaces which act as resonators. The solid floor construction is also objectionable, in the case of an elevated railroad, because of the additional darkening of the streets and the difficulty of disposing of the winter snows. It is likewise very heavy and would require expensive alteration in the steel stringers and cross girders.
>
> The suggested concrete encasement, on the other hand, does not obstruct the light or encroach on the present clearance lines. It requires no alteration in the steel work and the provision made for the additional weight adds to the strength of the structure. It can be molded so as to give the arch effect and thus materially improve the appearance as a whole. In cost it is cheaper than any other remedy which could be applied, and the expense of its installation is largely offset by the elimination of painting and tie renewals.



Proposed Concrete Casing for Union Loop Elevated Railways, Chicago, to Reduce Noise.

We wish we could agree with Mr. Strauss that "the science of engineering is fully equal to the task of effecting a practical elimination of this noise," i. e., the noise of elevated railway trains; but we must confess with regret that so far as we are aware, this problem is one which engineers have not yet successfully solved. That is now and is likely to be in the future a frequently recurring practical problem, there can be little doubt. In the elimination of grade crossings for example, where there is a choice between different types of structures for overhead bridges, it would be well worth while to know how different types of structures compare with reference to noise produced when carrying trains.

At the present time, however, we know of no authoritative data anywhere in engineering literature on noise production in engineering structures. The engineer who attempts to show what he knows in this field, will find, we feel sure, to say, that except for what his memory may retain of his school-day study of physics, he is at command very little of definite practical value.

We present Mr. Strauss' design, therefore, not because we approve it or accept the theory which he presents in support of it, but because it is suggestive and may perhaps lead some engineer to some definite study of the subject of sound prevention. It is to this end, also, that we take further space to criticize some of Mr. Strauss's statements.

In the first place, Mr. Strauss uses the term "elastic" in its popular rather than its technical sense, and says that the most essential change in the elevated structure for sound elimination will be to make the structure inelastic instead of elastic, meaning, we suppose, to make a structure which will yield less under a given load. It is not true, however, that elastic materials, or those which deform most under load, produce most sound. It may be true in comparing concrete and steel; but wood yields much more than steel under stress and is less noisy.

Again, the rate of transmission of sound through a medium has no relation, so far as we can see, to its noise producing capacity. To say that "the sound capacity of concrete is less than one-tenth that of steel "naturally would lead the laymen to suppose that a concrete viaduct would produce only a tenth of the noise of a similar steel viaduct during the passage of a train. Engineers familiar with the noise of trains passing over various types of structures will generally agree, we are sure, that while there may be less noise produced by a train on a masonry viaduct than on a steel viaduct, the difference is not so great as to be striking.

The fact is, we believe, that nearly all the noise of a train on a structure proceeds from the train itself and from the rails, and very little actually proceeds from the beams and columns and other parts of the structure itself. In opposition to this view may be argued the fact that passengers in a car can always tell when they pass over a bridge or trestle even in the night by the increased sound; but let us see what this sound of a train on a bridge really is. Is it a sound produced by the structure itself or is it the same sound as is heard when the train is running on solid ground, changed in volume and quality by the resonant, organ pipe effect of the hollow spaces beneath the track? We think that careful listening by an observer on a steel viaduct would show very little sound coming from beams or columns under stress and the great bulk of the sound coming from the wheels and the rails.

If this view of the matter is correct, the very expensive concrete sheating which Mr. Strauss proposes to apply to the Union Loop elevated in Chicago, would prove a disappointment so far as noise prevention is concerned.

But now to follow the matter somewhat farther, since we have already alluded to the fact that a train makes less noise on a masonry viaduct than on a steel structure, we may raise the query how much of that reduction in noise is due to the fact that in one case the ties are usually laid in ballast on an earth fill and in the other case they are laid directly on the structure? Again, the chief source of noise in a railway train is doubtless produced by the rolling of the wheels upon the rails. On a still night one can often hear the metallic ringing of the steel rails under the driving wheels of a heavy locomotive at a distance of a mile or more. Perhaps the most convincing evidence of the source of noise of a railway train is furnished every winter when a

...w storm buries the track out of sight. It may ...only a light fall of snow, so long as it covers ... track completely and leaves only the top ...face of the rail heads exposed as the train ...ses along. At such times a train seems to ...e almost without noise. The ordinary roar is ...horoughly shut off as if it were muffled, and, ...ed, that is just what the soft snow does. As ... as the snow becomes slightly packed, it ...smits the sound much more readily. There ... distinct difference in the sound of a train ...ng a fall of several inches of light snow, and ... same train after the snow has had some days ...ow compact. It is probable that the muffling ...e sound is not only due to the snow lying in ...act with the rails, but to the soft blanket ...h which the whole track and the ground on ...er side is carpeted, and which absorbs such ...nd waves as strike it without reflecting them.

To some extent the earth filling along side the ...is of a street railway acts like the snow cov... of a steam railway track. One never hears ...t metallic ringing of the rails from a street ...ilway roadbed, for example, to which we have ...eferred. But the earth transmits the sound far better than the soft and fleecy snow, particularly when paving blocks are used beside the rails and a street railway track is therefore much more noisy than a track covered with soft snow.

Probably the best imitation of the sound-deadening effect of snow on a railway track could be obtained by filling in sand against the sides of the rail, and this might be practicable on elevated railway lines. That it would have objections is also clear, but it would certainly be far less expensive than the encasing of the entire steel structure in concrete; and the probabilities seem good that it would be much more effective in reducing noise.

LETTERS TO THE EDITOR.

Hinged Masonry Arches: The Failure of the Maximilian Bridge at Munich.

Sir: In your issue of Oct. 27 you discuss editorially the failure of the masonry arch bridge over the River Isar at Munich, Germany.

The writer agrees heartily with you in your statement of the advantages to be gained by the use of the hinged arch as compared to the continuous arch, but it does seem that your concluding statement: that the wreck would not have occurred had the old method of continuous construction been followed, is, while strictly true, unfortunate, in that it seems to discourage the introduction of hinged masonry arches.

The fact that one hinged arch failed on account of a defective detail is certainly not to be considered as an argument against that type of structure, whether the defect was one of design or of material. Suppose a continuous arch were to fail on account of a defective keystone, would we argue that the three-hinged type is to be preferred because in that case there would have been no keystone, its place being taken by a hinge, and therefore the failure would not have occurred?

The writer has built a number of continuous arches, but never a hinged arch, yet he confidently expects to build some of the latter before many years have passed.

Yours respectfully, Wilbur J. Watson.

Osborn Bldg., Cleveland, O., Nov. 12, 1904.

How Can Cracks Be Prevented in the Ashlar Facing of a Concrete Wall?

Sir: Will you please inform me as to the effect of concrete backing on long ashlar forced walls, courses ranging from 30 to 18 ins., walls from 35 to 20 ft. in height above first course of stone, and from 16 to 10 ft. in thickness at first course, and 3 ft. thick at top course, foundations consisting of concrete from 4 to 16 ft. below stone line.

What is the best method to provide for longitudinal shrinkage, and to prevent, if possible, the ashlar face from cracking, presumably due to shrinkage of the concrete.

Yours truly, "Ashlar."

Washington, D. C., Nov. 10, 1904.

(We know of only one satisfactory way of preventing cracking of long retaining walls, and that is the use of expansion joints at intervals of 25 to 50 ft. Long walls faced with ashlar and backed with rubble usually develop open joints due to changes of temperature. Since a concrete backing adheres more strongly to the ashlar than the ordinary rubble backing, the ashlar stones are split along more or less nearly vertical lines at intervals. In a word, the ashlar facing behaves exactly as if it were a part of the concrete backing, and wherever a temperature crack develops in the concrete, there will be a temperature crack in the ashlar.

A rubble backing, on the other hand, is usually cemented less strongly to the ashlar face, beside being less strongly cemented itself. The consequence is that instead of temperature cracks at regular intervals in the ashlar, we have openings of the joints more or less irregularly, with the consequent destruction of the mortar in the vertical joints, necessitating frequent repointing.

While, so far as we know, a long ashlar faced wall with a rubble backing has never been built with expansion joints, it is certainly the only solution of the problem of preserving the mortar intact for any considerable length of time. As is well known, few long concrete retaining walls, are built without expansion joints; and if ashlar is used to face such walls it will be found equally necessary to provide expansion joints through the concrete and through the ashlar itself.—Ed.)

Some Suggestions on the Economic Handling of Earth Excavation.

Sir: In your issue of June 23, 1904, you published an article from an engineer in Australia describing the use of a hoisting engine for loading wheel scrapers. In an editorial comment, you suggest the use of a third wheel under the tongue to relieve the load on the horses' necks.

There seem to be possibilities in this engine loading far beyond the third wheel. Why not at once build four-wheeled scrapers, with capacity twice that of a No. 3, or, say, one cu. yd. With a scraper of this size, strong enough to stand the pull from the engine, there should be no difficulty in loading ordinary material, and a good team should handle it on the road as easily as a dump wagon.

The writer has sketched a four-wheeler, but finds there are many difficulties to be overcome in the design.

The pan should lift 8 ins. clear of the ground when loaded, and would probably need to be lifted still higher to dump.

Such a scraper would be the thing for long haul from cut to fill.

In your issue of Oct. 20 is described a power scraper used in Oregon. It looks pretty good, but is a step higher.

Mr. H. P. Gillette, in his "Earthwork and Its Cost," lays considerable stress on the time lost by steam shovels in waiting for cars to be spotted.

The Robins Conveyor Co., in 1902, published a catalog showing a belt conveyor carrying material from a 1¼-yd. shovel. This suggested to the writer that it would be well to have a similar machine for through cut, or any work.

A portable bin, on a wide gage track, would receive the material from the conveyor, and cars run under the gates of bin could be loaded as rapidly as handled. The bin would need to be large enough to hold material equalling several car loads, so that, during an unusually long delay in spotting, the shovel need not quit work.

If the conveyor has a "low level run" alongside the shovel in widening the cut, it could be run ahead of the shovel, and the conveyor and bin need be moved only every 20 ft., or 30 ft., for a rail length.

Has anything been published describing the use of steam, or electric shovels, in "mucking" in tunnels?

Yours truly, J. Harold Lane.

North Fork, Madera Co., Cal., Oct. 30, 1904.

(In our issue of Sept. 24, 1903, there is a photograph of a steam shovel at work in the Gallitzen Tunnel on the Pennsylvania R. R. Further than that the shovel used compressed air and handled the muck more economically than by hand, no data are given.—Ed.)

The Effect of Long Ruling Grades on the Tonnage Rating of Locomotives.

Sir: The effect of the length of ruling grades on the tonnage rating of locomotives is an important question in railroad location, and one on which I have not been able to secure any definite information.

What I wish to ascertain is the reduction in tonnage due to the inability of the engine to maintain its full steaming power continuously for long distances, and this should be considered entirely apart from the possible use of momentum on short grades. Excluding momentum, if the proper tonnage rating of a locomotive for a grade one mile long is 1,000 tons, what should be a suitable rating for the same gradient extended to 2, 3, 4, 5 miles, etc., to 15 miles? The traffic to be considered is slow and heavy freight trains on grades not exceeding 6-10 of 1%. Any information on this subject will be thankfully received. Yours truly. "E. G."

Roanoke, Va., October 19, 1904.

(Beahan's new treatise on "Railway Location" gives the following information covering the question raised by our correspondent.—Ed.)

Before dismissing the subject of tractive power by considering the weight on the drivers multiplied into a coefficient of friction, and from which percentage reductions are made, we must revert to the fact that an engine has a working percentage of efficiency. A driving wheel has not always its full weight upon it. Poor coal, bad water, a neglect on the part of the fireman, even when the engine is doing fairly good work, will reduce the efficiency. Most engines are "over cylindered," i. e., have cylinders so large they will use steam faster than the boiler can produce steam. This is especially true of engines designed for a division between "mountain" and "plains or prairie" divisions. An engine can then pull more for a short distance than it can pull for a long distance. Again we are obliged to say that the data are insufficient; but a beginning has been made. The reduction varies from 5% on an easy division, having light gradients and short maximum grades, to 20% on a division with difficult gradients and long maximum grades.

According to Mr. H. H. Vaughan, Mechanical Engineer, G. N. Ry.,

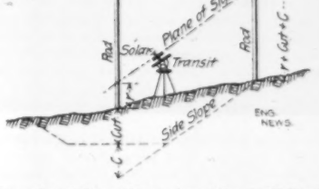
80% is the rating adapted for long, steep grades, such as those on the western end of the line (Cascade Mts.), where the engines are worked hard for a considerable time and the limit is imposed by the rate at which coal can be burnt if the fire is to be kept in proper condition. On grades not exceeding five or six miles in length, a rating of 85% may be adopted, or on long grades when the quality of coal used will admit of more rapid combustion. In some cases we have been able to adopt a rating of 90% for long grades, but this has been where coal and water have been both favorable, and this rating is generally used on undulating track where the maximum power is required for short distances only. A rating of 92% has been used where the limiting grade on a section of road has been short, and a majority of the line easier, and has given reliable results, in such cases, even though the train had to be started on a grade.

The Use of the Solar Attachment of a Transit for Setting Slope Stakes.

Sir: Very likely there are others beside myself who have employed a transit's telescope equatorial or solar attachment for the purpose of setting slope stakes.

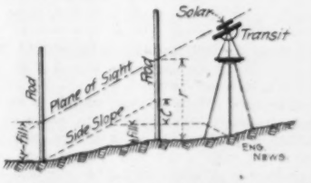
Under favorable circumstances the idea possesses so much merit that the method deserves to be generally known.

After setting up the transit, clamp the solar's telescopic line of sight perpendicular to the solar's polar axis. Then, by means of the horizontal and the vertical circles of the transit, place the solar's polar axis perpendicular to the plane of the proposed side slope. Now, by revolving the solar upon its polar axis, the solar's telescopic line of sight will generate a plane parallel to the plane of the required side slope. Read where this telescopic plane cuts a level rod held at the center stake. If the cross-section is to be in cut, to this reading (r) add the cut as marked upon the center stake and the distance C. Then



move the rod out from the center stake until the inclined telescopic plane of sight cuts the rod at the height equal to r + C + center cut. At this point drive the slope stake.

But if the cross-section is to be in fill from the rod reading (r) at the center stake subtract the fill as marked upon the stake and the distance C. Then move the rod out from the center stake until the inclined telescopic plane of sight cuts the rod at the height equal to r — C — center cut, and drive down the required stake.



At one setting, from three to five cross-sections may be rapidly staked out each way from the instrument. Like a level the transit can be set up anywhere most convenient. An instrumentman will quickly learn to select at a glance the most advantageous position. The horizontal angle may be turned off with sufficient accuracy by means of the magnetic needle.

For railroad work there is made an English theodolite in which the telescope, in addition to the usual horizontal

axis, has an axis perpendicular to the horizontal axis, so that the telescope may be set to follow outside slope work.

In a little pamphlet issued by Wm. Ainsworth & Sons, of Denver, Colo., directions are given for employing the solar attachment for the purpose of tracing out veins or outcrops. The solar's line of sight is set perpendicular to its polar axis, and the polar axis perpendicular to both the "dip" and the "strike" of the vein.

Yours truly, Ralph E. Parker.

P. Ranch, Burns, Ore., Oct. 4, 1904.

[It may be well to note that this method of slope staking would be particularly adapted to rough country where deep cuts are to be made on steep side slopes.—Ed.]

The Reliability of Bidding Prices and the Keeping of Actual Cost Records.

Sir: The writer has been very much interested in regard to your Construction News Editorial of Aug. 25 on bidding prices, also a letter from a correspondent, in your issue of Oct. 13, and your reply. He is inclined to think that your correspondent who signs himself "Wascostet" is not altogether clear in his illustration regarding practical judgment versus theory. "Wascostet" mentions a bridge as an illustration in favor of theory. If he refers to the stresses in the bridge, these are entirely a matter of theory, and he can accurately determine the stress caused by the proverbial fly, which happens to light on the structure. If he refers to the sections to be used in carrying these stresses, the recent discussions of eye-bars versus wire cables will show that this is largely a matter of individual judgment.

For the benefit of the younger engineers, would it not be well to give a summary of the different methods of obtaining bidding prices?

The first method which occurs to the beginner is to obtain preliminary prices from local contractors. It follows the old engineering rule, "If you don't know, ask and find out." This rule is safe, in fact, it is generally too safe, as the local contractor will always give a high preliminary figure. There is also the disadvantage that the engineer in return for the favor may feel under obligation to disclose information concerning projected work, which should be kept closely in hand.

After a few years' experience the young engineer begins to look back over his files for previous bidding prices. The writer agrees entirely with your editorial when you say that such bidding prices should be used with care. If the record covers a large area of country, it must be remembered that slightly varying conditions in different localities may change the totals very materially. Engineers should also be careful to note that almost all itemized bids have been balanced to conceal the contractor's real prices. The contractor does this to protect his costs from his competitors, and also to obtain a greater price for the items which in his judgment will overrun the engineer's estimate. Very often, too, the items which are to be put in place first are increased so as to obtain a large per cent. of the payments in the early stages of the contract. The writer recalls a sewer where the bidders were asked to separate the work into three sections in order to apportion the cost to three different districts of the city. The successful contractor bid the first very high and the other two quite low, with the result that the money for carrying on operations and for new machinery was available before the second section was begun.

Of course, the most accurate method is the one used by the careful contractor: that is, a detailed itemized cost. If the work involves concrete, the various items of the cost of broken stone, sand, cement, hauling, mixing and placing would all be carefully considered. The average engineer unfortunately does not possess the necessary data or experience to get good results by this method. In fact, a large number of contractors fail to follow it closely enough, often to their sorrow. The young engineer can and should collect all the data possible on the subject for future use. With very little trouble he can note each day the number of men on the job. He can also easily get the rate of labor and the material costs from the foreman on the work, and with these data he can figure out the actual cost of any part of the contract. If these detailed results are transcribed in a permanent book on rainy days, the record will be more than valuable in a few years.

The writer does not think that enough is said to the younger engineers in regard to making notes as they go along. They are told to do so in college, and promptly forget it along with much else. More than once the writer has been approached by young engineers employed by him concerning their advancement, and on questioning them he found that they had not the slightest idea of the special knowledge necessary for the prospective position. Valuable information had been passing through their hands for several years and they had never even noticed it.

Can not our educators do something more to make this fact stick? Very truly yours,

Contracting Engineer.

New Haven, Conn., Nov. 9, 1904.

Further Notes on Masonry Arch Design.

Sir: I am obliged to Mr. J. P. Snow and Mr. Emile Low for commenting on my note concerning depth of key in stone arch bridges. Mr. Snow says (Eng. News, for Nov. 3, 1904, p. 405), "ordinary arch bridges do not depend wholly on the ring for stability. The spandrel filling is good masonry and can be counted upon to resist distortion with the ring, although the bond is generally not all that it should be." This was admitted in my note (in Eng. News for Oct. 20, 1904, p. 363) and the discussion limited to either an arch ring with earth backing or to cases where there is no backing, the load being transmitted to the arch ring by vertical columns resting on the arch ring.

It is further admitted that the outside thin spandrel walls, where earth backing is used, are an aid in preventing distortion and in fact constitute a part of the arch in combination with the part of the arch ring on which they rest. Midway between these spandrel walls, however, their effect in preventing distortion must be very small and it seems unwise to count on it. Mr. Snow concludes that "a uniform depth of arch ring is more economical than one that varies, and if we have a depth that is ample for the pressure at the crown, the requisite additional thickness towards the spring line can best be made by the spandrel filling."

In the case of the stone arch bridge cited by Mr. Low, described and illustrated in Eng. News for June 21, 1900, dependence is evidently placed in the backing to judge from the drawing, Fig. 3, showing the top of the spandrel filling (what I have called the backing) and also from "the quantities comprised in the arch masonry:"

	Cu. yds.
Ring stones and skewbacks	1,202
Coping	286
Rubble	2,467

The question remains: Is it the best design to give a small uniform depth to the arch ring "that is ample for the pressure at the crown" and depend upon rubble backing for stability?

Is it not better to design an arch ring that shall alone be sufficient for strength and stability combined, not regarding the earth backing as contributing to the stability save in deadening the shock of a moving load? This eliminates uncertainty as to the amount of the aid furnished by the backing. It furnishes a scientific design in place of one by rule of thumb.

Further, a scientific design requires that the depth of arch ring, in large spans, be increased in going from the crown to the springing and, except for very flat arches, that a three-centered arch, or one approaching an ellipse, be used, so that the line of the centers of pressure for dead load should closely follow the center line of the arch ring.

The many graceful arches of reinforced concrete designed by Mr. Thacher and others, illustrate the economy that follows from a truly scientific design. It may be noted that the principles of design differ in this respect, that whereas in concrete or reinforced concrete arches, the question of strength predominates, in the stone arch stability is the ruling factor, so that it seems advisable to limit the line of the centers of pressure to the middle third. In case this is done there is for usual spans no fear of crushing or of exceeding the safe compressive strength of the stone.

Another point which I have made before (in "Theory of Voussoir Arches," 2d ed., p. 149), is that "the flatter a segmental arch, for the same span, the less should be the key (where crushing is not in question) since a line of resistance can be more easily inscribed within the same limits in a flat arch than in one of greater rise when the key is the same." In all empirical formulas for depth of key (Mr. Low's included) the reverse obtains, except in the formulas of Delardin and Dupont. I am glad that Mr. A. W. Buel in "Reinforced Concrete," p. 104, has emphasized the point noted.

In the diagram given in connection with my article in Eng. News for Oct. 20, 1904, the curve giving the depth of key (for *segmental* arches) after the elastic theory, supposes a constant radial depth of arch ring. If the latter is made to vary, and especially if a three or five centered arch is used in addition, the curve would be considerably lowered, possibly approximating Perronet's formula, the oldest of all the formulas for depth of key.

Respectfully, Wm. Cain.

Chapel Hill, N. C., Nov. 5, 1904.

A Reply to "Anti-Bond Monopoly" on the Awarding of Erie Canal Contracts.

Sir: Replying to the letter appearing in your issue of Nov. 10, signed "Anti-Bond Monopoly," I would like to call the writer's attention to a few points connected with the contracting business with which he does not seem familiar.

In the first place, if the Canal Board should divide the construction up in small sections as suggested, so that the small contractors could handle the work, it would mean one of two things, either some large firm would take a number of these small sections, making their bid for "All or None," which would of course be equivalent to bidding in a large section, or else the bids would be high for the reason that with a small quantity in view, expensive machinery for economical and quick handling of material could not be purchased.

As far as responsibility is concerned, the State could ill afford to experiment with cellar diggers, or contracts to persons having so poor a credit that they could not procure bondsmen.

Neither "Anti-Bond Monopoly" nor anyone else need fear that all the bidders on the proposed canal work will "get their heads together" and split the contracts up among themselves. The rivalry is too great and there will be too many bidders. During a number of years of contracting work I have never known of this being done; if tried, some outsider would step in and take the work.

The statement that a contracting firm bidding on a section will sub-let the work in small lots, is positively wrong. In all probability the contract will expressly forbid this, and, at any rate, the contractor will need large quantities to enable him to put on the expensive modern machinery necessary as before stated.

In regard to the State paying estimates every two weeks, this seems ridiculous to one familiar with work of any magnitude. It would require an engineering and clerical force as large as the contractor's. There are any number of contracting firms doing business in the State of New York which keep up extensive plants and organizations, and to these firms a bid on a $1,000,000 section does not seem so large, in fact it is a common occurrence, as the majority of your readers know, for firms to put bids on work amounting to several times that sum, and as a matter of fact, several of the canal sections are estimated at considerably less than that amount.

It is foolish indeed for anyone to imagine that firms with ample capital, extensive modern machinery and a perfected organization can be underbid 20% on this work by men without such means of construction.

I wish to state for the benefit of those who have had their ideas formed by a virulent press, in which statements have been made without regard to the truth, that our firm bid for and was awarded Section 10 under the $9,000,000 appropriation, and that in making the bid, we had no political or other influence to help us, but were awarded the contract on the prices named and our responsibility and ability to get the work done.

We expect to bid on the new work proposed, and again do so on the merits of our firm and prices, with no other influence whatever, and we feel sure that if our bid is low we will be awarded the work. For the benefit of "Anti-Bond Monopoly" I will say that the $1,000,000 sections he mentions are not so large, but that we would be glad to have several of them. Yours very truly,

Geo. W. Lee,

Engineer for Sundstrom & Stratton.

143 Liberty St., N. Y. City, Nov. 12, 1904.

(We desire to add, particularly for the benefit of contractors who may have been influenced by partisan press mis-statements and innuendoes, that the awards of Erie Canal contracts for more than a decade past have been made to the lowest bidders. At no time have contracts been let to contractors simply because of political affiliations, in the manner still so common in many of our cities. The worst that could be truly said of the system of awards and subsequent inspection and acceptance of Erie Canal work in the recent past has been that while the making of plans, specifications and estimates has been in the hands of the State Engineer, the awarding of contracts and the inspection of the work have been in the hands of the Superintendent of Public Works. Fortunately this two-headed management of the canal work has been done away with, and the inspectors of the work will in the future be under the State Engineer as they should have been in the past.—Ed.)

How Should Inspectors Be Appointed?

Sir: In an issue of your journal away back in June of this year you had an able editorial referring to the Slocum disaster and dealing with inspection of all kinds. The article was very extensively read and filed by many of your readers, and you deserve a large amount of credit for the sound common sense principles which you advocated. You seem to thoroughly grasp the situation as it exists.

Now as to the method of securing inspectors through the Civil Service examinations it is to my mind a most absurd way to secure first-class men. I am at present a Civil Service employee in a city department, but nevertheless I have no confidence in civil service. I am a mechanic of 35 years' experience, 30 of which I have spent in connection with first-class masonry, government, state and city works, in the West and in the East. In ten years I have taken the examinations. I have been successful in two and failed in one. When I reached nearly 90% in two how could I fail in one? I have A1 references from engineers for whom I had worked and value them highly, and yet to-day there are men who never put

...one nor laid a brick nor stretched a line nor plumbed ...all, who can't tell sand from loam nor bluestone from ...lite nor good mortar from poor mortar nor good brick ...poor brick, and yet they can pass a Civil Service ex...nation with high averages, aided, of course, by books ...so-called Civil Service schools.

...sk you, are such men competent? What are the re...? Darlington hotel accidents, Slocum accidents and ...s to follow. There are no doubt competent men as ...ctors, but they are handicapped by politics and su...ors; when there is no inducement for honesty there ...be none. Engineers as a rule prefer competent and ...st men where possible, but they, too, can be imposed ...on and are, frequently. Practical mechanics often dis... these matters and comment on the facts that they ...ive lower ratings in these examinations than clerks ...students, and in many cases mechanics will not en... examinations on this account. Mason.

...rooklyn, N. Y., Nov. 9, 1904.

(Nothing of Man's devising works with absolute ...fection, and this is particularly true of any...ing which has to do with that complicated mech...ism, Man. Does our correspondent know of any ...ge business enterprise under the management ...of either a single owner, a firm or a corporation ...in which every employee from least to greatest ...is selected with entire knowledge of his ability ...and capability, and in which promotions are made ...on merit alone, and wages, salaries, allowances, discipline, etc., are all adjusted with absolutely perfect fairness and equity? It is entirely safe to say that there is no such thing in existence. With the best intentions and the best efforts, mistakes will be made. And the most difficult task of all is to select from a lot of applicants the best men to fill a position. Suppose our correspondent had placed upon him that very task—to select for appointment fifty men for the position of masonry inspector. Will he not have to find out from each applicant what he knows about the work, what his experience has been, what sort of a recommendation he brings from former employers? In other words, he will have to give each applicant an examination; and this is the intent of the Civil Service law, that selection of employees shall be made for their ability to do well the work of the position they are to fill.

Perhaps the examinations are not always above criticism; few things are; but it is surely better to select men by some sort of examination than to select them on the strength of their political pull, or the proportion of their wages which they are willing to yield up to the campaign fund.

Our correspondent should look at things from the large point of view. It is true, doubtless, that Civil Service examinations are often a bugbear to practical mechanics; and sometimes they shut out competent men, who really know their business well; but who get "rattled" and cannot make a good showing when examined to find out how competent they are. These cases are as nothing, however, compared with the evils from which the Civil Service law has delivered us of the sale of positions for money and the use of positions as political rewards. One has but to contrast present conditions where Civil Service methods have been established and those which prevailed under the old regime to be satisfied that a great advance has been made.—Ed.)

Accidents and the Pay of Railway Employees.

Sir: Having been led, by a letter which I received some time ago, to take notice of the great number of railroad accidents in the United States during the past year, with their attendant terrible loss of life, I was very much interested in the statistics which you published on Oct. 27 last, and your comments on the same.

As to the causes for this terrible record it may be difficult to decide, but I think you have struck the keynote when you say: "It is quite within the field of possibilities, too, that the average railway employee of the present day is less reliable . . . than the average employee of 25 years ago," and later: "better men and better methods must be employed."

Now what is the cause of the poor qualities of the average railway employee? Is it not that in all branches of the service, the railroad man is notoriously underpaid and often overworked? The letter which I mention above, and which I now have in my possession, is in relation to an important position on one of the main trunk lines of the southern part of the United States. How important this position is may be judged by the following quotation from the letter:

Will say that duties of this position cover designing of railway structures, including shops, warehouses, depot buildings, trestles, section houses, tanks, masonry, culverts, retaining walls, piers, etc., preparation of plans, bills of material and estimates of cost of same, platting of surveys, calculation of earthwork and checking of estimates on construction. Salary paid is $100 *per month* with expenses paid by the company *when traveling* in its service.

(The italics are mine.) This letter is signed by the chief engineer of the railroad in question, and I have often wondered what kind of a man could be secured to fill such a position, for a salary much less than would be paid to a first-class draftsman, and what would be the effect on the road.

This is only a single instance in one department. But although it is not first hand, it has several times been reported to me that engine drivers were so overworked that they found themselves nodding in the cab while going at full speed. No further comment is necessary.

Is it any wonder, then, that a poor grade of man is secured by the railroads, and if by any chance a first-class man is employed, that he turns to something better at the first opportunity? It has been my experience that there is no economy in cheap men, and I should think the railroads would have discovered that fact by this time. A man may be cheap at $200 per month, and another dear at $75 or $100, when his errors, lack of experience, and consequent accidents and delays are taken into account. Again, a man who amounts to anything at all and feels that he is getting a fair salary will take an interest in his work and try to do the best with the means at his command, and thus gradually will the second of your suggestions, "better methods," be solved.

Let the railroads then pay a decent and fair salary for the positions which require it, and let them all employ enough men to attend to the business properly, and not lay off thousands, when it is more than suspected that the necessity of paying dividends on watered stock, rather than professed lack of business, demands it, and I think there will be fewer accidents and more safety both for the public and the employee. Yours very truly,

"Colonna," C. E.

New York, Nov. 5, 1904.

(Notwithstanding the statements of our correspondent, it would be very hard to show that inadequate pay is a general cause of accidents in the railway service. The pay of railway employees, and particularly of locomotive engineers, in the United States is higher by far than in any other country in the world, and in the case of locomotive engineers, a chief reason for paying such high wages is because of the heavy responsibility for the safe movement of trains which the engineer carries.

If our correspondent desires exact figures, he will find by the Interstate Commerce Statistics for 1902 (the last published) that the average daily compensation over the whole United States of employees concerned in train movement was as follows:

Enginemen	$3.84
Firemen	2.20
Conductors	3.21
Other trainmen	2.04

It cannot be said that these wages are insufficient to attract a desirable class of men to the operating force, particularly when it is remembered that these figures are the average for the whole country and include employees in all grades.

Nor do we think it could be shown that the railway employees of the present day are of poor quality. They may not compare favorably in all respects with the men who were doing a similar class of work 25 years ago, but that is due to changed conditions which affect all other employers of labor as well as the railways.

As for our correspondent's reference to inadequate salaries paid by railways for technical work; it is probably true that in proportion to the responsibilities carried and the amount of work required, railway officers receive very small salaries. The cases are not rare, for example, where a locomotive engineman, who is paid by the mileage he runs, will earn more money in a month than a division Master Mechanic who is at the head of a large force of men.—Ed.)

Further Notes on Flange Pressures of Two-Truck Railway Cars.

Sir: Since reading my paper before the New York Railroad Club, on "Flange Wear and Side Bearing Trucks" (Sept. 16, 1904, published in your issue of Sept. 22), the opinion has been expressed to me that the flange pressure upon the front outer wheel is not the same for the forward and the rear truck of a car, inasmuch as the friction of the center or side bearings, which as I showed *increases* the flange pressure upon the front outer wheel of the *forward* truck, *decreases* the flange pressure upon the front outer wheel of the *rear* truck.

The point deserves consideration. Granting that view, the lateral pressure upon the front outer wheel, a, of the forward truck, Fig. 1, would be increased by the friction of car bearings on hind truck in the proportion of the leverage of the car length between centers O-O_1, (usually 30 ft. in a freight car), to half the width between rail centers O_1-k, say 20 ins., that is in the proportion of 1:12.

In the car which I used for illustration, that part of the flange pressure upon the front outer wheel from center plate and side bearing friction was given as 3,000 to 13,000 lbs. one-twelfth of it would be 250 to 1,080 lbs., of which one-half, that is 125 to 540 lbs., would go to each outer wheel (a and c) of the forward truck. That part of additional flange pressure would, therefore, not be large.

But by the same reasoning the flange pressure upon the front outer wheel, e, of the hind truck should be decreased by the same 3,000 to 13,000 lbs., or instead of the total flange pressure, given in my paper as 18,000 to 28,000 lbs., there would be only 12,000 to 2,000 lbs. While this would not be enough to force the front outer wheel e away from the rail, it would nevertheless greatly decrease the flange pressure upon it. But observation and experience agree that the wheel e grinds very nearly as hard against the rail as the wheel a, and that the rear axles of both the forward and the hind truck of a car assume a radial position. If we examine into the cause for that radial position we may get further light upon flange pressures.

The normal position of the truck should be as in Fig. 2. The radius should pass through the truck center. That position is actually assumed on curves by empty trucks and by hand cars.

For that position the truck should turn through an angle larger by the angle α than if the rear axle were on the radial line o_1-O_2.

It is clear that for a car entering a curve (Fig. 1) the front outer wheel of the forward truck, a, is the first exposed to the lateral force turning the truck. This wheel a (and the wheel c) should moreover at this point move through the angle β faster than and ahead of the truck center O. But the wheel a is just then retarded by flange friction which acts like the friction of a brake shoe and by the fixity of the wheels upon the parallel axles, which tend to roll in a straight line. As the wheel, a, cannot and in reality does not move faster, the truck center must move slower relatively to the wheel in order that the truck may turn. We have, therefore, at this point two causes of retardation; one is the suddenly developed flange friction, and the other is the slowing up of the truck center. At the high speeds of 10 to 70 miles per hour (15 to 100 ft. per sec.), the car has a large momentum and the sudden retardation at the entrance to the curve takes the form of a shock followed by a rebound and swaying of the car body above the

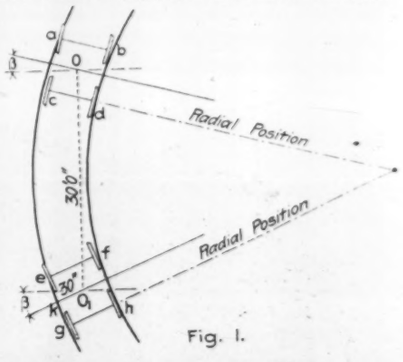


Fig. 1.

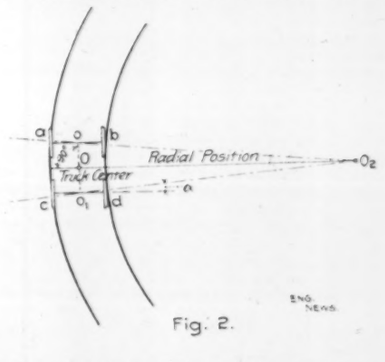


Fig. 2.

DIAGRAMS ILLUSTRATING FLANGE PRESSURES OF TWO-TRUCK RAILWAY CARS.

truck which is plainly felt and well known. At the moment of that shock, all four wheels of the truck offer lateral resistance to moving sidewise towards the inside rail. The intensity of that shock and the flange pressure upon the wheel, a, is therefore proportionate to the lateral sliding friction of all four wheels, that is 0.25 × 80,000 = 20,000 lbs. Immediately after the shock, when the truck center during the rebound of the car body has enabled the truck to turn, the flange pressure upon the front wheel a is reduced to that corresponding to the lateral sliding friction of only three wheels, a, b and d. The wheel c is the only one which moves forward normally on a radial axis. After the shock the wheel a exerts then a flange pressure equal to the sliding friction sideways of its own load, plus that of wheel b, plus the same friction

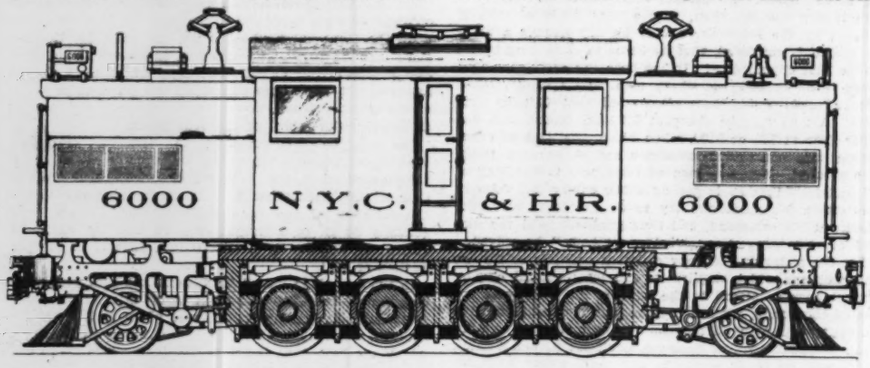


FIG. 1. LONGITUDINAL SECTION OF ELECTRIC LOCOMOTIVE FOR NEW YORK CENTRAL & HUDSON RIVER R. R.
Built by General Electric Co. and American Locomotive Co.

of wheel d, and plus the frictional resistance of the car bearings upon the truck, together from 18,000 to 28,000 lbs. flange pressure, as given in my paper, section 10.

The slip of the wheels by reason of fixity upon the axles does not affect lateral pressures although it affects the tractive force, which is not considered here. All these resistances added together prevent the turning of the truck to its normal position, Fig. 2, taking place as completely as it otherwise would. It turns only sufficiently to grind through the curve with the least change of angle, which is just the one for which the rear axle is in a radial position, instead of both axles being parallel to the radial line passing through the truck-center $O - O_2$, Fig. 2. In that position, with the rear axle on a radial line, all the lateral forces acting upon the truck seem to be in equilibrium.

The action of the hind truck is different. When the hind truck enters a curve, then in order to turn, the front outer wheel, e, must drop behind and therefore move slower than the truck center O. As that wheel is also retarded by the same momentary flange pressure of 20,000 lbs. as the wheel a of the front truck, the truck center passes on and the frictional resistance of center and side bearings is in this instance overcome by the momentum of the car body moving forward and ahead of the wheel e. The retardation by flange pressure of the front outer wheel, which in the forward truck is an obstacle to its turning is in the hind truck an aid to its turning. The flange friction upon the wheel e after the turning of the truck, is again only that from the lateral sliding friction of the three wheels same as in front truck. It is not likely, therefore, that a decrease of flange pressure in the hind truck takes place by reason of the friction of center and side bearings as suggested in the first paragraph.

As a rule, the wheel e of hind truck is hugging and grinding against the rail apparently not less than the wheel a of the forward truck. That the flange friction of wheel e is less than for wheel a can, however, be still conceded, but it is not so much less as at first suggested.

The rear axle g-h of the hind truck assumes the radial position for the same reason as the rear axle c-d of the front truck, that is the frictional resistance of truck bearings and the lateral sliding friction of wheels upon rails prevents the trucks from turning completely to the normal position shown on Fig. 2.

The rear outer wheel of each truck moves away from the outside rail on entering a curve at high velocity by reason of the retardation of the front outer wheel, which becomes a fulcrum, around which the car body, pushing upon the center bearing, is trying to turn the truck in the direction of the car. Thereafter no lateral force occurs large enough on the curve to overcome the lateral sliding friction between rails and wheels and to force the rear outer wheel c and g back against the rail.

As a result, each truck, be it forward or hind truck, assumes the position shown in Fig. 1.

It is readily seen, that if the truck can curve freely without much friction, and if further the car body can be prevented from adding its momentum to the shock at the entrance to a curve, then the retardation of the wheel a will be less and the rear axles of both trucks will not assume that radial position, but will assume more nearly the normal position shown in Fig. 2.

In that position the lateral pressure upon each outer wheel will then be only that required to push the inner wheel on the same axle sidewise on the inner rail.

There may, then, be only 5,000 lbs. lateral pressure from that cause for each outer wheel, instead of the 15,000 lbs. upon the front outer wheel alone, as given in my paper.

The means adopted in the truck designed by me, for lessening the momentum of the car body on entering upon a curve is a spring socket for the king-pin. The compression of the spiral ribbon spring greatly weakens the shock and consequent rebound by providing the time element for its transmission throughout the mass. The sufficiency of that detail for the purpose has been tested and found to work in practice fully as expected.

The good effect of a side bearing truck upon a curve, therefore, depends not only upon reducing as much as possible the friction between truck and car body, but also upon meeting the sudden retardation and the deadening of that peculiar shock on entering a curve from the inertia of the car body, as above explained. A successful solution of both these evils must reduce wear and tear of cars and track, and most important, must result in the hauling of more cars with the same draw bar pull.

In this connection, it may be interesting to note, from an examination of the stresses in bolsters and similar framework of freight car trucks, that the most of them should be much heavier in section, if designed on the basis of unit stresses and impact additions usual in bridge specifications. Floor beams and stringers and their connections are strained only from passing loads with long intervals of rest. But the framework and connections of car trucks are exposed to continuous impact stresses and frequent overloading, for which as a rule they are not dimensioned. One need not wonder therefore at frequent breakdowns and continuous repair bills.

Gustav Lindenthal.

45 Cedar St., New York City, Oct. 28, 1904.

Notes and Queries.

A. S., Brownsville, Pa., asks whether ordinary whitewash is a preservative of wood, stone and iron.

It is an excellent preservative of wood, so long as it retains its caustic properties. The decay of wood is due to the growth of bacteria and fungi and where the whitewash can be reached by a lime wash, their destruction is prevented. An occasional coat of whitewash on a shingle roof, for example, in a damp situation, will add much to its durability. On iron or stone, however, there would be no reason to expect whitewash to have a preservative effect.

CONSTRUCTION AND CHARACTERISTICS OF ELECTRIC LOCOMOTIVES FOR THE NEW YORK CENTRAL & HUDSON RIVER R. R.

For nearly two years past the New York Central & Hudson River R. R. has been engaged in developing designs and carrying out construction work on an extensive terminal improvement at New York City. One of the most direct factors in forcing this improvement is the existence of a tunnel nearly 2½ miles long in New York City—the Park Avenue tunnel—through which this railway and the New York, New Haven & Hartford R. R. reach their New York terminal, the Grand Central Station. A bad rear-end collision in this tunnel in January, 1902, which was due largely to the smoke and steam filling the tunnel, led ultimately to a decision on the part of the management to equip the terminal portion of their line for electric traction. Trains moving toward New York are to exchange their locomotives for electric locomotives at points 22 to 35 miles out (White Plains on the Harlem division, Croton on the Hudson River division).

Electric locomotives for this service were ordered of the American Locomotive Co. and the General Electric Co. in conjunction. These two companies worked out the designs, for the specified duty of hauling heavy through passenger trains at high average speed and therefore with high acceleration. Many strikingly novel features were adopted in this design, as will appear from the description farther on. Some time ago the first of these locomotives was completed, and was at once put under preliminary running test on an experimental track section near Schenectady, N. Y. This section is six miles long, from Schenectady west to Hoffmans; it is part of the New York Central's main line, and was equipped by the General Electric Co. with electric conducting equipment and power supply in close correspondence as to pressure, design of substations, etc., with the conditions laid down for the New York terminal equipment.

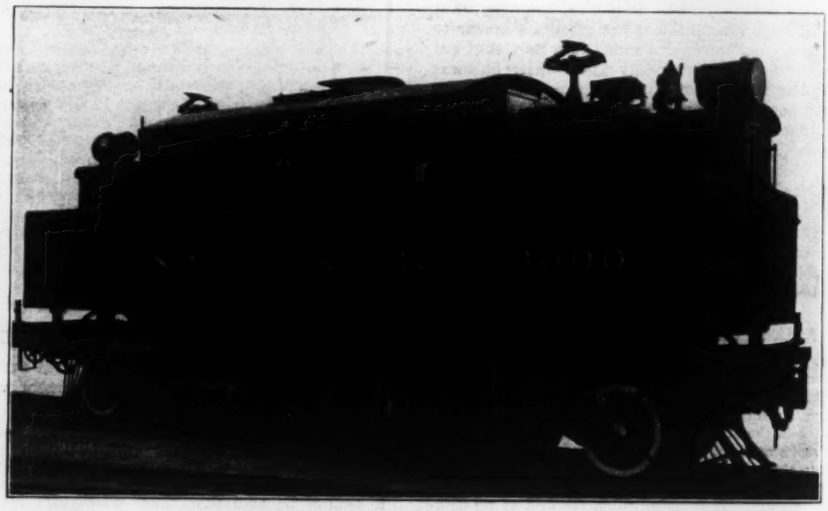


FIG. 2. VIEW OF COMPLETE LOCOMOTIVE.

The tests hitherto made have shown very satisfactory results. The locomotive, weighing 95 tons, is calculated to give a starting acceleration of from 0.5 to 1.0 miles per hour per second, depending on the weight of train hauled (up to 875 tons in weight). The running speed with a train weighing 500 tons using a single locomotive, is intended to be 60 miles per hour, but heavier trains can reach this speed with two locomotives in tandem. These results have been easily reached, as far as the tests have gone—the present experimental track being only about four miles long, not sufficient to develop the maxi-

um speed with a heavy train. Through the urtesy of the General Electric Co. we are en- led to present herewith an illustrated descrip- n of the locomotive, with some test results btained from the preliminary trial runs. .We e informed that the test running is to be con- ued all winter in order to yield information to the influence of winter weather on the k conducting equipment.

The strikingly new features of the locomotive : (1) Gearless motors; (2) Armatures

FIG. 3. UNDERFRAME WITH RUNNING GEAR AND MOTORS COMPLETE.

mounted solid on the axles, i. e., without spring quill; (3) A single field structure for all four armatures of a single locomotive; and (4) A spring-supported field structure in conjunction with solidly mounted armatures. Other important features, though less striking, are: (5) A four-axle driving gear with a radially-swivelling leading axle at each end; (6) Multiple-unit control, to handle the heavy currents and to enable two locomotives in tandem to be controlled from one point, and (7) Provision of both third-rail collector and overhead collector, allowing overhead conductors to be used at crossings.

Fig. 1, a longitudinal section through the locomotive, brings out clearly the most important of these features. The four driving axles are spaced as close together as the armature diameter and the field thickness permitted. The wheels themselves have a diameter of 44 ins. The peculiar disposition of the field-magnet structure allows a relatively large armature diameter, and, what is more important, it provides for considerable vertical motion of armature relative to field without contact and without seriously unbalancing the field of force. Each motor-armature has two poles placed at the sides and the poles have *flat faces* instead of faces concentric with the armature. The field structure is formed partly by the main frame, which is a steel casting. The two end pole-pieces are integral parts of this casting and extend from side to side of the frame. The three intermediate double pole-pieces are carried by heavy steel transoms bolted to the main frame and forming cross-braces for the frame as well as being in the magnetic circuit. The field coils are wound on metal spools bolted to the pole-pieces. Thus the side portions of the frame form part of the magnet-yoke.

The main frame is carried on semi-elliptic springs by means of equalizer levers; the springs rest on saddles over the caps of the axle-boxes. Thus, the magnet-frame of the motors, which, as described, is identical with the locomotive frame, moves up and down with the play of the springs, while the armatures are solid on the axles. The consequent vertical play between field-poles and armatures is permitted by the special construction used—that is, lateral poles and flat (vertical) pole-faces.

This construction, besides being strong and simple in design, greatly facilitates repairs and renewals, as an armature with its wheels and axle may be removed by lowering the complete element without disturbing the fields or any other part of the locomotive and a new element inserted in its place. All parts are also especially accessible for inspection and cleaning.

The front and rear leading trucks are of the radial type and are pivoted by means of radius-bars to the end frame of the main truck. The frame of the locomotive immediately above the trucks is supported by means of suitable links so that the truck is free to swing about its center and is self-centering on a straight track. This design is similar to the standard construction adopted by the New York Central & Hudson River R. R. for its steam locomotives. The underframing with motors, etc., complete is shown in the view, Fig. 3.

The detail photograph, Fig. 5, shows the general disposition of the armature with respect to the wheels. The commutator, like the armature itself, could be made of unusually large diameter. The brush holders are mounted on insulated supports attached to the saddles over the axle journals, thus maintaining a fixed position of the brush holder in relation to the commutator. These brush holders are made adjustable so as to allow for wear of the commutator and journal bearings.

The superstructure of the locomotive forms a cab for the operator. Its central portion contains the master controllers, engineer's valves and switches and valves required for operating the sanding, whistling and bell-ringing devices. This apparatus is furnished in duplicate, one set on each side of the cab, and is arranged so as to be easily manipulated from the operator's seat, while at the same time a practically unobstructed view to front and rear may be obtained from the windows. The air gage, meters, etc., are located so as to be easily read by the driver.

In the front and rear extensions of the cab are located the contractors, rheostats and reversers, arranged along the sides of a longitudinal corridor in boxes of sheet steel which are sheathed on the inside with fireproof insulating material (see Fig. 6). All of these appliances are therefore easily accessible for repairs or inspection. The corridor permits access from the locomotive to the cars.

The control system gives three running connections, namely (1) four motors in series, (2) two groups of two in parallel series and (3) all four motors in parallel. The motor reverser, contractors, rheostats and other controlling appliances are all of the well-known Sprague-General Electric multiple unit type. The master controller in this particular case is peculiar, however, in that it is fitted with a special operating lever about 24 ins. long, capable of being moved through an angle of about 75°, and fitted with a current-limiting device which locks the controller against too rapid switching on of current. This device consists of a friction clutch operated by an electro-magnet which is energized by the current passing through one of the motors; the arrangement is such that when the current exceeds a pre-determined amount the controller handle cannot be rotated further until the current has fallen sufficiently to allow the relay to drop. As long as the current does not exceed the desired limit the automatic feature is not in operation.

In the operator's cab there is placed a motor-driven air compressor having capacity of 75 cu. ft. of free air per minute and consisting of a vertical twin-cylinder compressor driven by two 600-volt direct current series motors. The compressor is controlled by a governor which automatically cuts the motors in and out of circuit when the air pressure falls below 125 lbs. or rises above 135 lbs. When running double headed, a reduction in air pressure sufficient to actuate any governor, simultaneously starts up the air compressors in both locomotives. Likewise when the air pressure has been raised and any one air compressor is closed down the other will be cut out of service.

The locomotive collects its current from the third rail by multiple-contact spring-actuated third rail shoes (see Fig. 8), whose supports are carried on channel irons attached to the journal box. There are four of these shoes on each side of the locomotive. In yards or terminals the large number of switches and crossings necessitates an overhead construction in places (Fig. 7) and additional contacts are therefore mounted on the top of the locomotive for collecting current when the locomotive is passing over these points. This device may be raised and lowered by air pressure controlled from the engineer's cab. A magnetic ribbon fuse is placed in circuit with each shoe

FIG. 4. VIEW OF LOCOMOTIVE AT HEAD OF REGULAR PASSENGER TRAIN.

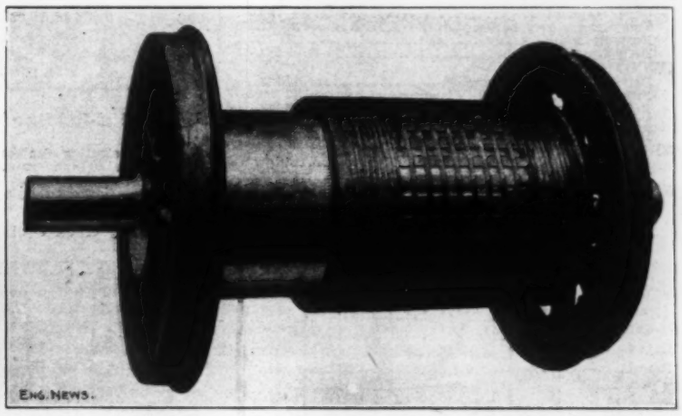


FIG. 5. ASSEMBLED AXLE AND ARMATURE.

FIG. 6. A SECTION OF THE SWITCH-GEAR; CONTACTORS AND RHEOSTATS ON RIGHT-HAND SIDE OF ONE END OF CAB.

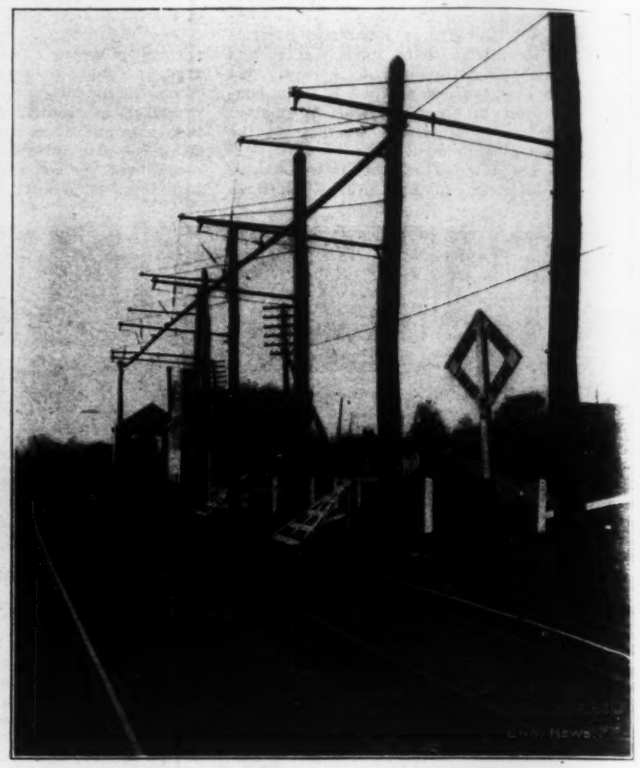


FIG. 7. SECTION OF EXPERIMENTAL TRACK ON N. Y. C. & H. R. R. R., AT SCHENECTADY, N. Y.; STANDARD THIRD-RAIL CONDUCTORS AND OVERHEAD CONDUCTOR AT CROSSING.

and overhead contact device so as to secure protection in case of accidental short circuit.

Two views of the locomotive are shown in Figs. 2 and 4 herewith, the latter illustrating a complete regular passenger train behind the locomotive.

The general dimensions of the locomotive and other related data are given in the following tabulation:

GENERAL:	
Class of traffic	Fast Passenger.
Gage, standard	4 ft. 8½ ins.
Total length over buffer platforms	37 ft.
Extreme width	10 ft.
Height to top of cab	14 ft. 4 ins.
RUNNING GEAR:	
Driving wheels, 8, diameter	44 ins.
Front truck wheels, 2, diameter	36 ins.
Rear truck wheels, 2, diameter	36 ins.
Trucks	Swing Center.
Diameter of driving axles	8½ ins.
WHEEL BASE:	
Driving	13 ft.
Total	27 ft.
WEIGHT:	
On driving wheels	138,000 lbs.
On truck wheels	52,000 lbs.
Total, in working order	190,000 lbs.

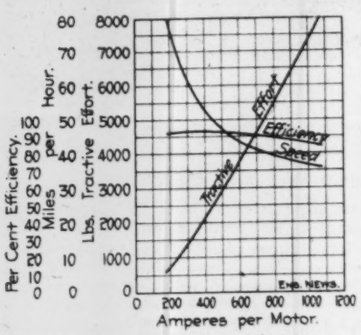


Fig. 9. Characteristic Curves of Motor.
44-in wheels; 600 volts; curves for one motor.

POWER:	
Supply, direct-current	600 volts
Conductors	Overhead and Third-rail
Motors, Type GE-84-A, number	4
Rating of each motor	550 HP.
Rated power of locomotive	2,200 HP.
Maximum power of locomotive	3,000 HP.
Normal full-load current	3,050 amp.
Maximum full-load current	4,300 amp.
Normal drawbar full	20,400 lbs.

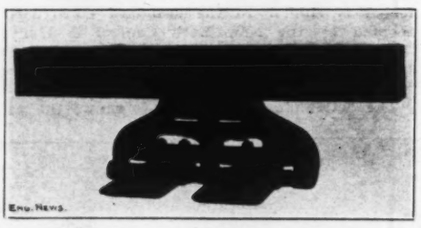


Fig. 8. Third-Rail Shoe for Covered Third-Rail.

Maximum starting drawbar full	32,000 lbs.
Speed with 500-ton train	60 mi. 1 hr.
Control—Sprague-General Electric multiple-unit, with automatic current-limiting lock in the master-controller.	

The testing track equipped for the purpose of trying out these locomotives is, as already noted, a 6-mile stretch of the New York Central & Hudson River R. R.'s main line just west of Schenectady, N. Y. It is practically straight and is ballasted to permit maximum speeds of 70 to 80 miles per hour. This track was equipped by the General Electric Co. with a protected third rail and at crossings with equivalent overhead construction.

Power is supplied to the line by a 2,000-KW. 3-phase 25-cycle generator driven by a Curtis turbine in the power-house of the General Electric Co. at Schenectady. This generator delivers current at 11,000 volts to a three-phase transmission line, which was built for the purpose, running five miles to Wyatts Station, where a substation has been put up. Here are the necessary transformers for reducing the line voltage, and a 1,500-KW. rotary converter producing direct current at 650 volts. The transformers are tapped for 1-3 and 2-3 full voltage for starting the converter from the alternating current side without drawing more than full-load current. To complete the substation equipment there are: A switchboard having a direct-current panel, an alternating-current starting panel and a high-tension panel, and an electrically operated oil switch for the transmission-line current. The substation equipment was so planned in location, arrangement, dimensions, etc., as to approximate the conditions laid down for the substations to be

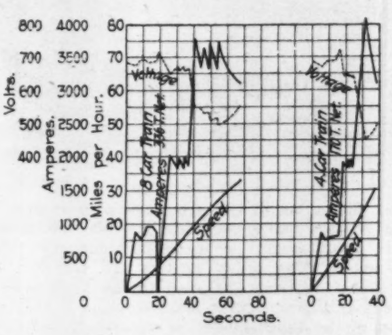


Fig. 10. Starting Curves of Current, Voltage and Speed for Complete Locomotive.

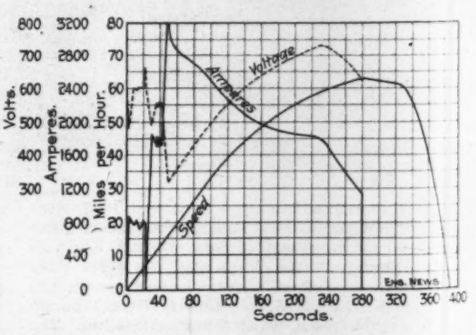


Fig. 11. Running Curves for Four-Mile Run; Speed, Current and Voltage Curves.
8-car train, 336 tons behind locomotive; 44-in. drivers.

...l in the New York terminal equipment, so ... practical experience in the operation of such ...stations may be obtained during the locomo... tests.

...inal experiments with the new locomotive ...e not yet been made, because the full length ...he testing track is not yet available and the ...ding and feeder equipment is not completed ...te, for example, the high voltage drop in the ...ve sheets, Figs. 10 and 11, herewith). How..., fairly representative curves have been ob...ed from a number of preliminary runs, the ... of the locomotive being fitted with all neces... recording instruments. The capabilities of the ...motive for starting are indicated by the curves ... Fig. 10, which show the speed, current and ...tage, plotted on time-abscissas, for two weights ... train, respectively 170 and 336 tons behind the ...motive. These starting tests were made near ... substation, where the voltage drop was mini...um. As shown, the heavier of the two trains, ...sisting of eight regular passenger cars, was ...rted with an average acceleration of ½ mile ...r hour per second, reaching a speed of 30 miles ...r hour in 60 seconds. The lighter train was ...celerated at the rate of about 0.8 mile per hour ...r second.

The complete run curves shown in Fig. 11 were ...btained with the eight-car train, 336 tons behind ...locomotive. This test, being made at greater ...verage distance from the substation, shows a ...greater drop in voltage and hence a lower accele...ration. The available length of track was not ...sufficient to reach maximum running speed; it will ...be seen that at the moment of shutting off power ...the train was still accelerating. A speed of 63 ...miles per hour was reached in this test. In a ...similar run with the four-car train a speed of 72 ...miles per hour was attained, which also was be...fore the end of the accelerating period. The ...greatest drawbar pull developed during these two ...tests calculated from the slope of the speed-...curves was 27,000 lbs. in the case of the 8-car ...train and 31,000 lbs. with the 4-car train. The ...latter figure represents 22.5% of the weight on ...drivers. At this point the maximum current was ...drawn, 4,200 amperes at 460 volts, representing ...also the maximum power, 1,935 KW. or 2,200 HP. ...at the drivers. If the voltage were kept up to 600 ...volts for this current, the power consumption ...would be 2,520 KW. Allowing for the power ...lost in the motors, this means nearly 3,000 HP. ...available at the drivers. No commutation diffi...culties are experienced at this current. Tem...perature runs have not yet been made. The pre...liminary runs so far made have not shown any ...appreciable warming-up of the motors.

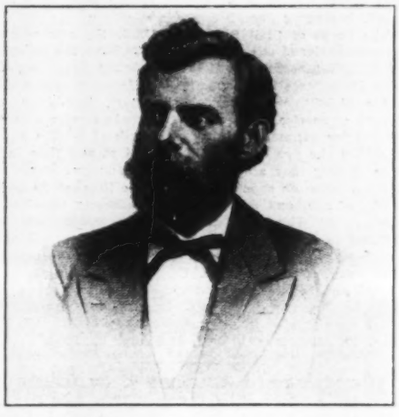
L. F. G. BOUSCAREN.

By Ward Baldwin, M. Am., Soc. C. E.

Louis Frederic Gustave Bouscaren was born Aug. 26, 1840, in the island of Guadeloupe, a large part of which island together with the title of Marquis had been granted by the French Government to his great-grandfather, a member of the French military engineering corps, as a reward for distinguished services. Mr. Bouscaren's parents purchased a large tract of land in Grant County, Kentucky, and settled there in 1850.

Mr. Bouscaren attended school at St. Xavier's College, Cincinnati, in 1852; in Georgetown, Ky., in 1853; and in France, where he studied at the Lycée St. Louis, Paris, until 1860, and was graduated from the Ecole Centrale as Ingenieur des Arts et Manufactures in 1863, with high honors. Upon his return to his home, he first entered the employ of Samuel Hannaford & Sons, Architects, of Cincinnati, as a draftsman; then he was mechanical draftsman for the firm of Lane & Bodley, manufacturers of Mill Machinery and Engines, in Cincinnati, in 1864-65. He became an assistant engineer of maintenance of way on the Ohio & Mississippi R. R. in 1865-66, under Thomas D. Lovett, Chief Engineer, and continued under E. C. Rice, Chief Engineer, in 1866-67. In 1868 he was engaged in making railroad locating surveys in Indiana; and in 1868-69 he was assistant to E. C. Rice on construction work on the St. Louis, Vandalia & Terre Haute R. R., and made the preliminary and location surveys for the St. Louis & Terre Haute R. R. From 1869 to 1872 he was Principal Assistant to E. C. Rice on the St. Louis & South Eastern R. R., and was at the same time Chief Engineer of the O'Fallon & Belleville R. R. In 1872-3 he was Principal Assistant Engineer on the Cairo & Vincennes R. R. In 1873 he was employed under Thos. D. Lovett to prepare specifications and take charge of the construction of the bridge for the Cincinnati Southern Ry. over the Ohio River. He was appointed in the same year Principal Assistant Engineer of Construction of the Cincinnati Southern Ry., and upon the resignation of Mr. Lovett he was appointed Chief Engineer. When the Erlanger Syndicate acquired the lease of the Cincinnati Southern Ry. in 1881, Mr. Bouscaren was made Chief Engineer of the railroad system controlled by this syndicate, and retained this position until 1886, when he resigned.

During the ten years from 1886 to 1896 he was engaged in private practice as Consulting Engineer, and during this time was employed on various important engineering works including several bridges over the Ohio River, and the construction of new water-works for Covington, Ky. He was a member of the committee appointed by President Cleveland to investigate and report upon the best plan for bridging the North River. In 1896 he was appointed Chief Engineer for the Commissioners of the new water-works for the



G. Bouscaren

City of Cincinnati, which position he held at the time of his death, Nov. 7, 1904.

He was married in 1876 to Miss Helen Seymore Lincoln, daughter of Timothy D. Lincoln, a distinguished lawyer of Cincinnati. He leaves five children, one of whom, G. Bouscaren, Jr., is an electrical engineer in business at Newburyport, Mass.

Mr. Bouscaren was an active and honored member of the American Society of Civil Engineers; member of the Institution of Civil Engineers; member of the Societe des Ingenieurs Civils. In 1881 he was a member of the Board of Direction, and, at the time of his death, was a Vice-President of the American Society of Civil Engineers.

Throughout his career Mr. Bouscaren's earnestness of purpose, clear sense of duty, and unswerving fidelity to the highest professional ideals, imparted to his work a character that has not only merited the stamp of approval, but has made much of it epoch-making in the history of the engineering profession.

His thorough scientific training, profound scholarship, and ready mastery of technical details enabled him to depart from the beaten path of precedent, and to apply the fundamental laws of science to determine the correct solutions of engineering problems; and by his courage and persistence in doing so, he has left a record of achievement in the advancement of engineering knowledge and methods that stands as an imperishable monument to his own memory and as a valued inheritance to his professional brothers.

The spirit that animated him in all his work may be well illustrated by an incident in his early career, when he had just begun his studies at the Ecole Centrale. His first drawing was presented for criticism, and the Professor said, "You will never make a draftsman." In telling of this, Mr. Bouscaren said that he at once determined that he would make himself become a good draftsman, and, that he succeeded, is evidenced by the fact that the drawings he made when in the employ of Lane & Bodley, in 1864, immediately after graduating from the Ecole Centrale, have not, in the half century that this firm has been conducting business, been equalled by any of the many able draftsmen who have worked for them to this time.

In his earlier professional work, before going with the Cincinnati Southern Ry., Mr. Bouscaren had established a reputation for ability and skill that led to his appointment to the responsible duty of taking charge of the construction of the great bridge for the Cincinnati Southern Ry. over the Ohio River, which was to contain the then longest truss span in the world. His specifications prepared for this bridge were long recognized as a model, and in many particulars, notably in the use of a concentrated typical loading, marked a radical departure from standards previously in vogue.

In connection with this work, Mr. Bouscaren asked for authority to have tests made to determine the strength of full size compression members of bridge-trusses, in order to determine whether the formulas based at that time on a few tests of small pieces of material would apply to full size built members. He was granted the desired authority, and made the first comprehensive set of tests on full size bridge members, both tension and compression, that had been made up to that time, a service that has been of inestimable value to bridge engineers.

While Principal Assistant Engineer of Construction, Mr. Bouscaren introduced many changes in the methods of computation of details of bridges; and the bridges then built under his supervision were regarded as examples of the most advanced stage of the art of bridge building, and were subject to much adverse criticism on account of their then considered excessive strength. Among these bridges was the then and still famous Kentucky River Bridge for which C. Shaler Smith, one of the great bridge engineers of that time, was the contractor. This bridge was designed originally as a continuous bridge, but Mr. Bouscaren declined to approve the methods used by Mr. Smith in his computations, which were based on the assumption of fixed points of contraflexure. As a result, the points of contraflexure were made fixed by cutting the lower chords and enclosing the cut ends in loose sleeves, thus producing the first great cantilever bridge in this country.

While Chief Engineer for the Erlanger syndicate, Mr. Bouscaren built the New Orleans & North Eastern R. R. and the Vicksburg & Meridian R. R. A notable piece of engineering work on the former road was the creosoted wooden trestle over the Lake Pontchartrain Marshes, having a total length of 21 miles. In order to prepare the creosoted timber for this trestle, Mr. Bouscaren designed and built what was at that time the largest creosoting plant in the country.

Among other works conducted by Mr. Bouscaren, the strengthening of the cables of the Cincinnati and Covington suspension bridge, and the construction of the masonry lined reservoirs for the City of Covington have been of particular interest.

In connection with the new water-works for the City of Cincinnati, he used the largest caisson ever built, in the pump well for the low service pumps, and designed coal storage sheds and bunkers which are interesting on account of the novel details used and of their great capacity.

The plans adopted for the water-works of Cincinnati, and much of the other work done by Mr. Bouscaren has from time to time been fully described and illustrated in the columns of Engineering News.

He was the author of standard specifications for railway and highway bridges, which have been very widely used, and he has enriched engineering literature with contributions and discussions pub-

lished in the transactions of the societies of which he was a member.

Mr. Bouscaren was a man whose influence has been effective in the elevation of the scientific and ethical standards of the profession. He was of most pleasing presence, courteous, dignified, generous in his judgment of others, of inflexible integrity, capable, resourceful, and in character, ability and achievement was fully deserving of the exalted rank he had been accorded in his profession.

THE TURKISH RAILWAY SITUATION.

The following material relating to the present status of railway construction and management in Turkey is furnished to us by one familiar with present conditions in that country. The matter is interesting though the monetary statistics seem to be given in "round figures."

The railways of Turkey may be divided into two distinct classes: (1) The roads of 1.5 m. or 4.92 ft. gage; with a minimum radius of curve of 250 m., or 820 ft.; and a maximum grade of about 1 in 130. (2) The roads of 1.05 m. and 1 m. gage; minimum radius of curve 100 m. and 80 m.; and maximum grades, about 1 in 164.

The maximum fare per passenger per kilometer, is given in American money as: First-class, $0.027; second-class, $0.02; and third-class, $0.013. The freight rate per metric ton per kilometer is placed at: First-class, $0.035; second-rate, $0.026; and third-rate, $0.022. But the railway companies make reductions on these rates up to 60%, under certain conditions.

Since the accession of Sultan Hamid several lines of railway have been constructed by European companies. In spite of the fact that there is comparatively little commerce or industrial enterprise in the Turkish Empire, and there is little traffic for railways, the present Sultan favors the construction of railways, and the Government, each year, expends large sums of money in insuring the constructing companies from any loss due to the falling off of receipts. Of course, this government guarantee decreases in amount each year.

The Hamidie du Hedjaz Railway, intended to eventually connect Damascus and Medina with Mecca and the Red Sea, is being built by the Turkish Government, under the supervision of a High Commission, appointed by the Sultan. When completed this line will have a total length of 2,000 kilometers, or 1,240 miles. The work of construction is being done by the Turkish militia, the officers and privates being paid according to the work performed. About 400 kilometers, or 248 miles, are now in operation, with regular trains running. As the proclaimed object of the completion of this road is the transportation of Mahometan pilgrims to Mecca, the funds for its construction are raised by contributions received from Mahometans all over the world. Up to the present time the cost of construction has not exceeded $7,500 per kilometer, or about $12,000 per mile; so that the work must have been managed very economically. The total amount received from pious contributors has amounted to about $10,000,000; and the Sultan awards to each contributor, according to the amount of his donation, a special decoration in gold, silver or nickel.

All material used is purchased by contract from the lowest bidder. Belgium has furnished 25,000 tons of steel rails, and 20 engines, 200 passenger coaches and freight cars have been bought in Belgium and in Germany; the Pennsylvania Steel Co. has supplied 20,000 tons of rails. At first, wooden ties were employed, but as these were found to be unsatisfactory in this semi-tropical country, metallic ties are now alone laid. The country traversed is very fertile; and it has gained considerably in population since the railway has been partly opened.

The Damascus-Moan section of the line passes through a mountainous country requiring the construction of several tunnels and viaducts. To connect this line with the Mediterranean the government has lately been building a branch railway to Haifa, a port on the sea. Of this line 75 kilometers, or 46.5 miles are being regularly operated. The remainder of this branch, however, is of very difficult construction, requiring a number of bridges, viaducts and tunnels, and heavy grading.

In Engineering News, of March 3, 1904, will be found an illustrated article—with a map, showing the present railway situation in Syria and Palestine.

FIVE ASSISTANT CIVIL ENGINEERS in the U. S. Navy are to be appointed early in 1905, and an examination of candidates is to be held at the New York Navy Yard, beginning Jan. 9 next.

The Corps of Civil Engineers, U. S. N., now numbers 32 commissioned officers, of whom 28 have the full-grade of Civil Engineer and 4 that of Assistant Civil Engineer. The five officers to be appointed in January next will receive $1,500 per annum at the start, increasing with length of service. Officers of full-grade receive $2,400 to $3,500 per annum, according to length of service and on reaching the age of 62 or if disabled at any time in the line of duty they are retired on three-quarter pay.

Candidates for appointment must be between 23 and 28 years of age, and must pass a satisfactory physical examination. The rules governing the examination were printed in Engineering News of July 21 last, and copies of them can be obtained by addressing the Secretary of the Navy, Washington, D. C., to whom application for permission to take the examination should be made. The examination questions used in previous examinations have been printed in Engineering News of Jan. 27, 1898; Jan. 19, 1899; May 1, 1902, and Aug. 13, 1903.

THE 15,000-TON BATTLESHIP "NEW JERSEY" was launched at the yard of the Fore River Ship & Engine Co., at Quincy, Mass., on Nov. 10. The vessel is 435 ft. long and 76 ft. 2½ ins. broad on load water line, and draws about 24 ft. The trial displacement will be close to 15,000 tons. It is intended to make a speed of 19 knots. The propelling power is furnished by two four-cylinder triple expansion engines of 19,000 I.H.P., driving twin screws. The main armament of the "New Jersey" comprises four 12-in. rifles, in the usual arrangement in pairs in two turrets, one at each end of the superstructure; eight 8 in. rifles, of which four are in turrets superposed on the 12 in. turrets, while four are in two side turrets; and a gun-deck broadside battery of twelve 6 in. rifles, six on each side. Torpedo tubes are also provided. The vessel is armored with an 8 ft. waterline belt, full length, 11 to 4 ins. thick, and a 6 in. casemate belt, 245 ft. long.

A LARGE CONCRETE-STEEL ARCH BRIDGE over the Isar River, near Munich, Germany, is reported to be in trouble before completion. The structure has two spans, each 70 m. (230 ft.) in span, with 42 ft. rise. The 26 ft. roadway is supported by isolated columns, except at the center, where it rests directly on the arch-ring. The approaches to the main spans consist of concrete-steel girder spans, each 28 ft. long. The main spans are three-hinged, the hinges being designed to be secure against slipping (see a report of the slipping [illegible] in a stone arch bridge over the same stream in [illegible], Engineering News, October 27, 1904). The br[illegible] was to have been opened for traffic on Oct. 15. [illegible]ported, however, that the abutment at one end [illegible] cracked, supposedly from settlement, and the b[illegible] has been closed to traffic.

A SERIOUS HEAD COLLISION on the Union [illegible] Ry. near Azuza, Wyo., on Nov. 12 resulted in th[illegible] of 13 persons. A west-bound passenger train collid[illegible] an east-bound freight. The latter had been give[illegible] orders, and in consequence failed to make its [illegible] point in proper time. The blame is laid on a te[illegible] operator.

A TROLLEY CAR WAS STALLED ON A CR[illegible] at Passaic, N. J., on the morning of Nov. 7. A [illegible] Passaic St. was just on the Erie Ry. crossing w[illegible] power failed. An Erie train struck the car a f[illegible] ments later and destroyed it, but fortunately the f[illegible] sengers of the car had been able to get out bef[illegible] collision.

CIVIL SERVICE RULES are shortly to be app[illegible] to all employees of the Panama Canal Commission, a[illegible] ding to a Washington dispatch of Nov. 14. The rule[illegible] will be made to apply to all employees except those d[illegible] appointed by the President, ordinary laborers and [illegible] 30 excepted positions.

WIRELESS COMMUNICATION between the ground and a balloon was successfully tried at the World's Fair grounds at St. Louis, Mo., on Nov. 11. The balloon was free, and is said to have been as much as 1,400 ft. above the surface when the messages were received by it. There were no transmitting instruments on the balloon, but experiments in sending from the balloon are said to be contemplated.

ELECTRIC LIGHTING is to be introduced into the city of Kabul, the capital of Afghanistan, by direction of the Ameer, who is also said, by the "Far Eastern Review," to be desirous of operating his ordnance factories by electric power.

LARGE FREIGHT CARS are being introduced by the Great Central Ry. of England. One recently completed is an all-steel car of 40 gross tons capacity, measuring 41 ft. 2¾ ins. long, 8 ft. 3 ins. in width and 8 ft. 8 ins. in height. It is said to be much the largest freight car ever built in Great Britain. The empty car weighs 33,500 lbs.

WASHING ASPHALT PAVEMENTS WITH HOSE streams is the only way to thoroughly cleanse their surface, says Dr. John McGaw Woodbury, Commissioner of Street Cleaning of New York City. This emphatic statement was brought out by a letter written to Dr. Woodbury by the Merchants' Association of New York, complaining that Fifth Avenue had been in bad condition since a change had been made from washing to sprinkling. Dr. Woodbury says that by applying water with sufficient force the gummy mud which clings to the asphalt "every month of the year in (under?) dry conditions can be removed." This method can be employed whenever the temperature of the air is above 45° F. He says that a nozzle pressure of 40 lbs. per sq. in. and a stream directed against the pavement at an angle of 45 degrees will do the work. Sprinkling merely loosens the gum without washing it off, leaving a street "surface upon which the horse has little or no footing," while "motor vehicles, losing their traction, skid so as to be completely beyond the control of their drivers." Dr. Woodbury well says that the removal of the dirt which forms dust and not the sprinkling of dust after it is formed is the proper way to treat a street. He speaks of "washing with compressed air machines or with (water drawn through—Ed.) hose from hydrants." Many miles of streets have been washed in New York with satisfactory results.

THE RAILWAYS OF THE OTTOMAN EMPIRE.

Name of Road.	Date of Opening.	Road: Gage, Metres.	Road: Length Kilos.	Road: Stations, No.	Rolling Stock: Engines, No.	Rolling Stock: Passenger Cars, No.	Rolling Stock: Freight Cars, No.	Annual Returns: Average No. Passengers Annually.	Annual Returns: Received from Passenger Traffic.	Annual Returns: Gross Receipts.	Receipts per Kilo.
Oriental... {Constantinople	1870-'78	1.5	826	52	72	242	1,563	10,000,000	$600,000	$1,650,000	$2,000
Oriental... {Salonica		1.5	448	28	18	54	377	150,000	130,000	806,000	1,800
Salonica-Constantinople	1893	1.5	510	43	35	120	728	200,000	120,000	806,000	600
Solonica-Monastir	1891	1.5	218	16	8	28	190	150,000	110,000	414,000	1,900
Anatolia... {Angora	1890	1.5	576	42				1,073,000	300,000	1,440,000	12,500
Anatolia... {Konia	1895	1.5	444	25	61	199	1,156	70,000	80,000	355,000	800
Cassaba... {Old	1870	1.5	266	32	22	110	468	1,500,000	150,000	1,000,000	3,000
Cassaba... {New	1894	1.5	251	15	10	41	401	50,000	40,000	150,000	600
Aidin	1866 / 1888 / 1891	1.5	515	57	58	131	1,155	700,000	800,000	1,439,000	2,000
Mercin-Adana	1886	1.5	67	8	7	9	90	100,000	30,000	107,200	1,000
Beirut-Damascus	1893	1.05	247	36	28	28	215	200,000	130,000	470,000	1,900
Moudania-Brusa	1893	1.0	42	6	7	14	40	90,000	25,000	50,000	1,200
Jaffa-Jerusalem	1890	1.0	87	7	5	15	50	90,000	90,000	150,000	1,700
Hama-at-Rayak	.....	1.5	168	10	6	20	60	30,000	10,000	89,000	500
Damascus-Mecca	.....	1.05	400	15	20	60	100	20,000	20,000	.....	[2]

[1]Prolonged 200 k. towards Bagdad. [2]Under construction.

ENGINEERING LITERATURE

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The need for a general index of the annual proceedings of the American Water-Works Association increases with each volume. The provision of such an index, it appears from the volume noticed elsewhere in this issue, has been under consideration, but no definite action to that desirable end seems to have been taken. Next year will witness the twenty-fifth annual convention of the Association. It would be particularly fitting if the quarter-century of existence were marked by the publication of a first-class index. To be of the greatest service such an index should be analytic; that is, the papers and discussions should be indexed in detail, instead of merely by title. Of course an author index should be given.

Masonry is a term that, strictly speaking, should be applied only to structures built by masons. Concrete built by unskilled laborers is, in the strictest sense of the term, not masonry. We feel quite safe in saying that no mason will concede that a mass of ballast, sand and cement is masonry in any sense of the term. Nevertheless, there is need of a term broad enough to include all structures built of stone and mortar, whether the stone be hand laid or in fragments that are shoveled into place. On the other hand, there should be a term that will always denote stone masonry built by masons. Perhaps it would be well were the word masonry used as a general term to include stone and brick masonry and concrete. To denote stone masonry the word stonework might be used, just as the word brickwork is often used instead of the more cumbersome expression, brick masonry. We should like to receive the views of our readers on this subject of masonry nomenclature.

Whether some single and comparatively short term will come into use in place of the terms reinforced concrete or concrete-steel, is open to question, although there is probability that a shorter expression will be coined and accepted. In the early days of concrete the French word beton was used by English and American engineers, but in spite of the general acceptance of the term for a while, it was gradually crowded out by the term concrete. A long term, or one having a foreign sound, stands little chance of a long life wherever the term is in frequent use by workmen, regardless of any favor that may be shown to it by writers and scholars. At present, if we may judge by a number of recent instances, workmen prefer to use the three-syllable expression concrete-steel to using the five-syllable expression reinforced concrete.

There is great need in the mechanical world to-day of a thoroughly first-class and up-to-date treatise on the art of lubrication. The engineer who will compile such a treatise will receive a better reward than often falls to the lot of a writer of technical books and he will be a benefactor as well to his profession and to mankind at large. It is probably not generally realized how much more important is provision for lubrication in mechanical design at the present day than it was in the early days of the machine era. With the old type of slow-moving machinery, lubrication was of small importance and almost anything would suffice. Intermittent lubrication and anything whatever in the way of grease or oil was the prevailing custom. Under modern conditions it not unfrequently happens that the successful operation of a complicated machine depends wholly on ability to keep its bearings from overheating.

But if the engineer wishes information upon the subject of lubrication, where shall he turn to find it? He may be in doubt as to the relative merits of oil or grease for locomotive crankpins, or it may be a question between oil cups feeding by different systems, or a reservoir system of lubrication with either gravity or force feed; or the distribution of oil in a bearing by spiral grooves or other methods may be in question.

The fact is there has been a great development in a thousand directions in the art of lubrication and it is wholly without systematic record in technical literature. As a result our mechanical engineering work at the present day is often seriously deficient in the matter of lubrication, because designing engineers are not informed as to the best methods which are open to their use. Such knowledge as does exist on the subject of advanced methods of lubrication is due chiefly to the enterprise of manufacturers in pushing into notice such things as the use of graphite, filters for cleansing oil, automatic lubricators of various types and the use of ball and roller bearings.

The engineer, however, ought to get his knowledge regarding all these and a hundred other advances in the art of lubrication from some more authoritative and impartial source than the publications of an interested manufacturer. He wants to know what are the drawbacks as well as the advantages of roller bearings. He will not adopt an automatic lubricator for the sake of saving oil until he is entirely assured that it will be no more likely to stop feeding and cause a hot bearing than the older types of oil feeder. If engineers could have at their hand an authoritative treatise on lubrication, covering just the practical matters which come before them in machine design, they would be encouraged to adopt and use modern methods of lubrication as they could be in no other way.

It will be apparent from what we have said that the compilation of such a treatise as we have in mind would be a long and difficult task. A large amount of data and records would have to be gathered together from many different sources and the whole would then have to be treated with discrimination, careful judgment and intimate expert knowledge in order to make a work on which the user could rely for advice as safely as on the aid of a consulting engineer.

We are not hopeful of the appearance of a work which shall fulfil such an ideal as we have set forth; but we have deemed it worth while to set forth the need of such a book in the hope that some engineer possessing the requisite qualifications may be impelled to undertake its preparation.

Technical Literature and the International Association for Testing Materials.

The word Literature involves the conception of something written, printed, or otherwise recorded in form available for future reading. Further than this, it usually involves the conception of something *published*, available to the world. The term *Technical* literature carries these conceptions with it, merely in restriction to a special field. A lecture or paper presented before a technical society is not by itself technical literature; it becomes this only when printed in the society's journal of transactions. Every technical society, in consequence, publishes all (or the more important) papers presented before it. It regards itself in one sense as a machine for producing technical literature. And in reality, when we subtract the variable social function, the production of selected technical literature is the sole function of such societies. This function is exercised in a series of steps: (1) The character of the society leads individual members to describe before it their best work; or, in many cases, the society undertakes, either by committees or as an organization, certain work which in many cases could not be accomplished by individuals. (2) The papers and reports are discussed, corrected and purified, either in oral discussion after being read, or in writing after they have been published. (3) The papers, reports and discussions are laid before the world in printed form; as noted, this third step in part may precede the second. In any case, the third step, the actual publication, is vital to the society's function as a producer of technical literature. For, as we have premised, literature is not literature without publication. If the society does not publish, and that with reasonable promptness, it is little more than a social organization.

The International Association for Testing Materials is a large society of excellent purposes and of high grade (as concerns the character of its membership). It was projected, and for some years continued, as a world-society. Three years ago the American members withdrew from direct membership and formed an independent society, though this latter has since supported the work of the surviving International Association by regular contributions. One of the reasons leading to the withdrawal was that the International Association failed of its purpose, in a large measure, by failure to meet the very condition above laid down; prompt and complete publication of its papers and reports.

A recent bulletin of the International Association gives some later information on the same subject. The bulletin summarizes the proceedings of the last council-meeting, held at Vienna, February, 1904. It was reported at this meeting that 47 papers were on hand, of which three had been already published. The cost of publishing the other forty-four papers, and the reports of committees, was estimated at 45,000 fr. ($9,000), against this, the entire wealth of the Association, plus the net income for 1904, represents but 18,000 fr. ($3,600). Clearly, the Association's work in producing technical literature is beset with difficulties.

It is proper to note that the estimate includes the cost of publication in three languages, which is almost absolutely essential as the Association is constituted. In order, however, to equilibrate cost and cash, it was resolved to publish each paper only in its original language, adding thereto a brief abstract in each of two other languages. A further fact to note is that the papers will not be published, will therefore not become technical literature, before the next general Congress, which will be held probably in 1905. This also results from the international nature of the Association, which renders it possible at best to hold Congresses no oftener than once in two or three years.

It appears that the International Association is a very awkward and inefficient engine considered as a producer of technical literature. We ven-

ture the opinion that this inefficiency is due largely to the international feature. If the quality of the literature produced were to show an increase from the same cause, this would be at least a countervailing fact. But as yet it has not appeared that better work was accomplished because the organization is international. The committee reports have generally had the one-man character which can only exceptionally be avoided in technical societies. Further, the bulletin already mentioned contains several passages of the following tenor:

Professor ————, Chairman of the ———— Committee, regrets to have found too little support among the members of his commission (committee) and he fears not to be able to further the matter.

That is a very disheartening statement, even if it occurs but once in a single meeting. In the bulletin noted, the same statement in substance appears in half a dozen different cases! The presumption thereby raised of the total failure to secure increased quality by international cooperation is very strong. The very mildest conclusion is that the gain of quality from the international character of the association is insufficient to counterbalance the unavoidably lower concentration and efficiency.

We incline to the belief that it is impracticable to secure efficiency in this field by an international society. Unity of action, administrative considerations, the language difficulty—every consideration favors separate societies in the various countries interested. A glance at the work of the American Society for Testing Materials before and after its formation as an independent body offers striking testimony in favor of the separate society plan.

The plan of having separate national organizations need not involve absolute absence of intercourse between the various societies. Nor would the fact that each society would publish its proceedings in its own language make the contents materially less available. As a more positive argument we have the fact that differences in conditions and requirements in the different countries call for more or less specialized development of the fields of testing and specification. Briefly, we submit that the interests of technical literature—as well as other interests—speak strongly for the substitution of separate localized national societies of material-testing for the present International Association.

CORRESPONDENCE.

Cataloguing Trade Publications.

Sir: The project of a library of municipal engineering in New York City, referred to in your issue of Oct. 13, is one which, when carried through, will prove satisfying to all concerned. As the founder of the first trade library in successful operation in this or any other country, I beg leave to congratulate through you the Municipal Engineers of the City of New York upon this exhibition of an alert and progressive spirit.

In the development of their system of classification of the trade catalogues of the supply industries, those directly in charge will meet the most serious problem in their library work. They need scarcely turn for aid in making a satisfactory classification to the professional librarians in the broad field of bibliography, or to that more limited class which has had experience in classifying technical trade literature in special libraries, as we have learned in establishing the Shaw Trade Library, in San Francisco, now nearing its third year of existence. The field of this library comprehends all industries, and from the outset the vital problem was to give every catalogue its appropriate place. The work involved in the classification of the literature which adorns the shelves of our great libraries is well defined and runs along beaten paths, but your trade catalogues require special and original treatment. This is because there is an interdependence in all industrial products where the lines merge into one another, and because of the interblending and variety of uses in modern tools and machinery, as well as because (in many cases) of the careless and unscientific compilation of catalogues. After studying the methods in vogue, with a view to determining the best general classification for a trade catalogue library and to conform to broad lines, as exemplified in the American and British Patent Office reports and journals, the United States Census Reports of Manufactures, the indexes of trade publications and the classifications adopted by the publishers of standard trade directories, I realized that none fairly met the needs of a trade catalogue library containing some forty thousand odd trade catalogues. The most satisfactory that I could do for the practical ends sought was to take the trade directories for models and make them the basis of my system of classification.

The Library of Municipal Engineering, restricted as it is to the manufactured products of iron and steel, and also stone, clays and cements, etc., will possibly admit of an easier solution of the problem of library classification.

As to the general scheme involved in the establishment of the Library of Municipal Engineering which you referred to, I can safely predict that it will be one of the most welcome of reference libraries in that city. The successful inauguration of the New York Library of Municipal Engineering has my heartfelt wishes.

Henry G. Shaw,
President Shaw Trade Library, Inc.

San Francisco, Cal., Oct. 24, 1904.

(The matter of collecting, filing and indexing trade publications, including not only catalogues but also such publications as bulletins, information pamphlets, etc., will increase in interest, we feel certain, as time goes on. And that for two reasons: (1) Because the value of trade catalogue libraries will be more appreciated as such libraries grow in number and become more generally known; (2) because the prodigious and increasing bulk of trade literature makes such libraries on the one hand more necessary and valuable, on the other hand more difficult to organize, arrange and index.

In our issues of April, May and June, 1904, this subject received discussion, both editorially and in letters from our readers. This discussion may profitably be referred to by those whom the above letter awakens to an interest in the subject.

Our own wish is that some few of the larger libraries in the country take up trade catalogue collection in equal rank with the other library work, as has been done in part by the New York Public Library. The engineering libraries of the various large national societies are, of course, most directly in line for such work, though it might be assumed that a general library would be the more careful in carrying out the historical part of the plan.

It seems to us, also, that a library of restricted scope, like the proposed library of the Municipal Engineers of the City of New York, has a better chance to gather and arrange a fairly *complete* collection of trade catalogues, in its own field alone, than has a library of wider range. Of course, among a number of such special collections, separately covering the different branches of engineering, there would be much duplication; but the great value of having each one as complete as possible would go far toward counterbalancing this disadvantage.—Ed.)

Methods and Costs of Excavating Rock.

Reviewed by Daniel J. Hauer,* C. E.

ROCK EXCAVATION.—Methods and Cost. By Halbert Powers Gillette, M. Am. Soc. C. E., M. Am. Inst. M. E., Late Assistant New York State Engineer. New York: M. C. Clark. Cloth; 5½ × 8 ins.; pp. 376; 56 figures in the text. $3.

The author's former treatise on "Earthwork and its Cost" was given a cordial reception and has been put to constant use by both engineers and contractors. This companion book, which may be considered the complement of the previous one, has already been given a warm welcome and will no doubt be ranked as one of the most important engineering books of the year.

In most construction that is presented to the engineer, the problem of excavation, either earth or rock, is the first to be considered. In spite of this, it is noteworthy that but few engineers have ever written of costs and detailed methods of doing this class of work. Consequently in making estimates of the probable cost of structures, such excavation costs have either been a mere guess of the experienced engineer, based on previous work, or else taken from files of engineering journals that make a practice of publishing prices of contract work. At times either method may be of little use. Mr. Gillette now presents us details of costs of various pieces of work done, with conditions surrounding them given, and comments made upon the methods, from which he derives certain formulas that may be used in setting a price upon future work. The author is certainly to be congratulated upon such an eve ment.

The book is written in an attractive ner, and can not but appeal and be of great u the inexperienced student, as well as to the om- plished engineer and contractor. The wh ub- ject is presented in such detail and given so few technical terms that not only can the be used as a student's text-book, but even on- tractor's foreman, who may not be overm of a book reader, will find the volume to his li as well as of vast benefit.

The treatise deals with every variety rock excavation: open cut, trench, tunnel, an ose material. Quarrying, railroad and cana ork, subways, prospecting, mining, shaft sinking lift- ing, stoping, subaqueous excavation, and der breaking are also treated. For each class ork a number of records of costs are given and far as possible a detailed description accom- nies such records. Various methods are explai in detail, and pointed and useful comment fre- quently made upon the given method.

The subject of drilling, both by hand and wer drill, is very fully covered by the author, and sts of the different modes are given, with the ap- proximate amounts of work that can be do in a day. Some novel methods of drilling and lac- ing drill holes are given, and many useful sug- tions are made. Mr. Gillette calls attention to the fact that most engineers and contractors who have kept cost records of drilling have omitted many important details of cost, so that the greatest benefit possible can not be derived from the data given.

Steam and compressed air plants for drilling are compared in one chapter and the merits of each are clearly stated. The common fallacy of an air compressing plant being more economical to operate than steam is commented on, and much useful information in the operation of such plants is furnished. Mention is made of the gasoline compressor, and a useful future is predicted for it.

Three chapters are devoted to the properties, the care, handling and methods of using explosives. These chapters would stand reprinting in pamphlet form, and should be placed in the hands of every man who uses explosives. The dissemination of such information would be the means of preventing that loss of life which is yearly sacrificed through ignorance and negligence.

The cost of loading and transporting by various methods is discussed and an entire chapter is used in describing the rock excavation done on the Chicago Drainage Canal.

The longest chapter is given to descriptions and costs of railway tunnels, and especial attention is called to the remarkably rapid work on the Simplon tunnel. The last chapter is full of interest, as it is devoted to mining work, setting forth the cost of drifting, shaft sinking, and stoping.

Wherever possible formulas for cost of work have been derived from the data given. A large number of useful tables have been compiled, while a number of apt illustrations and diagrams add to the attractiveness of the book.

Much information has been gathered from various journals and published works, while a vast amount was secured by private correspondence. In every case this is acknowledged in the text, and reference to page of book, or date of issue of journal is given, thereby largely adding to the usefulness of the information.

The author bewails the lack of published information on the subject of which he writes. As numerous as works are on engineering subjects, but few so much as touch on the actual costs of construction work, and in the fulness of cost data Mr. Gillette easily leads. He has entered a field never before covered, for Morris, Trautwine and Drinker only gave us approximations that have but little real value in estimating costs of prospective work. The example that has now been set should be followed, and Mr. Gillette's plea for more data should be heeded. Both the engineer and contractor will be benefited by the publication of such costs, for the contractor who counts such information as "stock in trade" is not only standing in his own light, but is attempting to hold back the wheels of progress. The contractor can educate the engineer with such informa on,

*1739 North Broadway, Baltimore, Md.

and the former will reap the reward and benefit from the engineer's knowledge.

It is to be hoped that a larger and more comprehensive volume can be issued as a second edition, as the one fault now to be found with "Rock Excavation" is that there is not enough of it.

Part II. of a Treatise on Statics of Structures and Mechanics of Materials.

STATIK DER BAUKONSTRUKTIONEN UND FESTIGKEITSLEHRE, VORLESUNGEN UBER.—By G. C. Mehrtens, Professor of Engineering at the Royal Technical College at Dresden (Saxony). In three volumes. Vol. II., Statically Determinate Structure. Leipzig: Wilhelm Engelmann. Paper; 6¼ x 9¼ ins.; pp. 339; figures in the text. 14 marks, or $5.60 in the United States.

Just a year ago we expressed the sentiment that*

> books should in most cases be written primarily not for the student, but for the practicing engineer . . . When there is no need for a book on a given engineering subject except for the use of college instruction, then there is no excuse for its existence.

We are led to reiterate our belief in this sentiment by the perusal of the second volume of Professor Mehrtens' ambitious work on "The Statics of Structures and Mechanics of Materials." This second volume deals with several most important applications of statics: the calculation of bridges, certain kinds of arches, and retaining walls; it is therefore of very much greater interest than the first volume† with its more preliminary matter. On this account the characteristics of the entire work are more obvious.

If judged by the special criterion above quoted, Professor Mehrtens' treatise is by no means ideal. It was not written "primarily for the practicing engineer." It professes to be a series of classroom lectures as delivered by the author at the Dresden Technical College. Its subdivision and arrangement were determined unconsciously by pedagogical requirements rather than by the demands of the engineer. Yet the author intended that his work should be a treatise for the use of the engineer as well as a text-book for the student. This expressed intention is evident enough at many points in the text, which points show clearly that the author strove to write for the eyes of the engineer. But the commendable intention was insufficient to overcome the effect of the pedagogical origin and purpose. The work is a bulky, though clearly and well written, text-book for the student, and correspondingly falls short of being an ideal working reference for the engineer.

Stress is laid on the "pedagogic" character of the book because in the case of the subject treated the fact is more important than it would be in the case of some other branches of engineering work. The design of bridges, buildings and other structures is, as a whole, in a very advanced condition. In certain other branches of the engineer's work this is not true; there is a large gap between theoretical study and commercial practice. In those cases a new presentation of theory is, at most, in missionary service: it has its best effect when it appeals to the young student of the subject and prepares him for the task of later improving the standard of the art. In those cases, then, it is permissible that we should write text-books, books specially for the student, though it will be better if they are also as practical as possible. On the other hand, in the field now being considered, a field where practice is fully abreast with theory, literary endeavor is best directed toward producing convenient and illuminating treatises for the daily use of the engineer. The student of the subject should learn directly from current practice by making the manuals of the engineer his text-books; he will thus secure a better result than if his knowledge were drawn from specially-prepared text-books, mere tools of pedagogy. The application of these remarks to the work under review is this: We are not yet overcrowded with good manuals on structures; on the contrary a new thoroughly good manual of bridge building and general construction would be received with eagerness. Professor Mehrtens' work, if drawn on a slightly different plan, might have met this demand. Failing in that, it is merely a detailed, comprehensive text-book for students.

The first volume of the work included the analysis of various statically-determinate frames under fixed loading; thereby the analysis of roofs and bridges under dead load was covered, at least in its principles. The more intricate matter of live-load analysis is handled in the second volume, and makes up about one-half of this volume. The other half of the volume is devoted to Arches (considering three-hinged analysis only) and Retaining-Walls.

In the section dealing with live-load analysis, influence-lines are made the key to the whole subject. No attention is paid to uniform moving loads, but the treatment plunges at once into wheel-loads. Proper emphasis is laid on the utility of the reaction influence-line for deriving the various moment, shear and stress influence-lines, for which the author deserves credit as a pioneer. However, he develops this idea still farther, to the "total influence-line" for an entire series of wheel-loads. This latter idea, which is not especially fruitful, is given disproportionate space. In contrast therewith, the derivation and clear explanation of the important criteria for maximum moment and shear in ordinary trusses receives too little attention. Here, for the case of moment in ordinary trusses, the author gives the form

$$\frac{W_1}{l_1} = \frac{W_2}{l_2}$$

instead of the much more convenient form

$$\frac{W_1}{l_1} = \frac{W_1 + W_2}{l_1 + l_2} = \frac{W}{l}$$

and the text explanation in conjunction therewith is also deficient in clearness. Thus, the author interprets the above criterion as follows: The loads W_1 and W_2 must not only be proportional to the span-sections l_1 and l_2, but also must be distributed as uniformly as possible over the span-portions l_1 and l_2; an interpretation which implies a faulty conception of the conditions. The same remarks, as to text and the form of equations, apply to the shear criterion. In connection with this important part of live-load analysis we note also that no mention is made of the utility of moment-tables for wheel-loads, which are widely used in this country. Again, the use of the Eddy wheel-load diagram is not even referred to.

After concluding the treatment of single simple trusses, the author considers complex truss combinations, that is to say: cantilever structures, three-hinged arches, combinations of three-hinged arches with cantilevers, flexible arches stiffened by hinged trusses, etc., all being statically determinate. The inclusion of a treatment of these forms is valuable; it brings to mind that a fuller discussion of these forms is desirable in our manuals for practicing engineers, which usually neglect all but simple cantilevers and three-hinged arches. As given here, however, it is not as direct and practical as this service would require.

A short discussion of the drawing of influence-lines by kinematics is given, but this is more in the way of theoretical suggestion than with practical aims.

The second half of the book is entitled "Solid Rib Arches and Retaining Walls." Its two divisions are quite distinct, though grouped together. The theory of arches is introduced by a demonstration of the fact that in a curved beam the formula $M = SI \div c$ does not hold exactly. But for all ordinary cases, the author continues, this formula may be employed. Then are developed principles of designing and analyzing the solid-rib arch of three hinges (the only statically-determinate case). It is implied that all this matter is of direct application to masonry arches. A method is given for finding the critical section of an arch, based on the principle: The critical section is that section whose moment influence-line includes the maximum area, positive and negative areas being added without regard to sign.

The elastic theory is now drawn upon momentarily in order to show that in an arch with fixed ends the pressure line intersects the center line in at least three points, or, if arch and loading are symmetrical about the center line, in at least four points. This principle is used to approve the usual practice of drawing the pressure line for live-load on half the arch plus full dead load, and laying down a rib which shall include this line in its middle third. The analysis for maximum joint pressures is then developed at some length, together with the design of a stone arch. A good historical review of the development of the theory of masonry arches closes the section on arches.

It happens that many of the men who worked at the problem of arch-theory are also among those who developed the theoretical study of earth-pressures and retaining-walls. The two subjects have much in common: both deal with masonry in bending, both are concerned with variable and undetermined pressures of backing-material, and both involve various bold assumptions as to the behavior of the structure. It is rather natural, then, that the history of retaining wall theory should be given in close connection with that of arch-theory. Professor Mehrtens brings them close together, by following the above-noted section on arches almost in continuity by a section on the history of theories of earth pressure and retaining-walls. The only English name which appears here is that of Rankine; French engineers, and later a few Germans, contributed nearly the whole of the work in this field. Coulomb, prominent in both subjects, about the time of our Revolutionary War laid down the lines which the theory of retaining walls still follows with little variation from his analysis.

The modern theory of earth pressure is explained mathematically at some length. The entire remainder of this section is occupied by the demonstration of graphical solutions for various cases of retaining walls, with vertical or inclined wall, with level top or surcharge, with live-load surcharge, etc. Several examples are worked out in detail. It is worth noting that the two subjects, Dams and Reservoir Embankments, which would appear to stand in direct connection with Retaining-walls, are not touched on. Again, in the subject of Retaining Walls proper, no treatment is given of walls having an extended heel projecting into the earth backing, such as is often used in the case of retaining-walls or abutments built of reinforced concrete. The theory here, both as to earth pressure and as to analysis of stresses, would differ materially from that used for simple masonry retaining-walls.

An appended section gives some tables of weights of bridges, live-loads, dimensions of arch bridges, coefficients for retaining-walls, etc.

The general features of the book: its usually clear and precise language, its admirable typographical equipment, the use of color-printing in many of the diagrams, etc., are the same as in the first volume. The third and final volume of the work is promised for the end of 1905.

A HISTORY OF COLUMBIA UNIVERSITY, 1754-1904.—Published in Commemoration of the 115th Anniversary of the Founding of King's College. New York: The Columbia University Press. The Macmillan Co., Agents. London: Macmillan & Co. Cloth; 6 x 9 ins.; pp. 493; many plates and a few illustrations in the text. $2.50 net.

The history of Columbia University covers a period of 150 years. What may be termed the general history of the University has been written by Prof. John Howard Van Amringe, Dean of the College, and by Prof. Munroe Smith. This general history occupies the first 267 pages of the volume; then follow the histories of the professional schools and affiliated colleges, each written by one of the professors. The School of Mines and Associated Schools is treated by Prof. Henry Smith Munroe, and The School of Architecture, by Prof. Alfred Dwight Foster Hamilton. Professor Munroe's chapter is not only a history of the 40 years of engineering education at Columbia, but it also gives an outline of the probable development of the engineering schools in the future. Among other interesting statements we find the following:

> It is not improbable that in the near future the Faculty may take action looking toward the requirement of this six years' course for all professional students. In other words, the complete professional engineering course of study finally contemplated at Columbia University is six years in length, the first three being devoted to what may be termed a general college training and the last three to technical work.

Many will welcome the day when this change takes place at Columbia and in other engineering schools.

*p. 37, Engineering Literature Supplement to Engineering News of Nov. 12, 1903.

†Reviewed on p. 25, Engineering Literature Supplement to Engineering News of Sept. 17, 1903.

An American View of British Sewage Works.

Reviewed by George W. Fuller,* M. Am. Soc. C. E.

BRITISH SEWAGE WORKS.—And Notes on the Sewage Farms of Paris and on Two German Works. By M. N. Baker, Ph. B., C. E., Associate Editor of Engineering News. New York: The Engineering News Publishing Co. Cloth; 6 × 9 ins.; pp. 149. $2.

This book contains a description of 24 sewage works in actual service in Great Britain and of three on the continent of Europe. It is based upon notes made by the author during a tour of inspection during the late winter and spring of 1904. The subject matter corresponds quite closely to the features which would be noted by the practicing engineer upon visiting these works with the view to getting points for guidance in the solution of problems of his own. It is fortunate for American engineers that the more essential facts regarding typical works in operation in England have been recorded in terse and convenient form by an engineer who for a dozen years or more has kept in close touch with, and has published descriptions of, the more important works and investigations in America devoted to this branch of sanitary engineering. The book partakes somewhat of an official nature in that in each instance the descriptions were submitted before publication to local officials in order that they might make such revisions as they desired. Such responses were received from all places but one in time to be embodied in the book.

At the outset the author points out the advantages of the expression "sewage works" which appears in the title, and which has certainly much to commend it for adoption in this country. It makes a clear distinction from "sewage disposal works," including the dilution process which does not require works of artificial construction; and it also differentiates from "sewage purification works," which is perhaps too pretentious a title for many existing plants. In all of the descriptions the nomenclature of various devices and processes is maintained in a consistent manner and in accordance with terse and logical descriptions which are given in Appendix II.

The book is divided into four parts, descriptive of works in which the final treatment of the sewage is afforded by contact beds, percolating filters, sewage farms and chemical precipitation works, respectively. Appendix I. records observations made at the sewage farms of Paris, at the settling and screening plant at Wiesbaden and the settling tanks at Frankfort-on-the-Main.

In Part I. are descriptions of eleven works in which contact beds are employed for final treatment, namely, those at Sutton, Exeter, Yeovil, Barrhead, Manchester, Oldham, Burnley, Rochdale, Hampton, Chatterton and Aldershot. In Part II. are descriptions of five works in which percolating filters afford the final treatment, namely, at Birmingham, Salford, Accrington, York and Salisbury. In Part III. sewage farms are described as found at Nottingham, Leicester, Reading, at the military school at Sandhurst and at the Aldershot camp. In Part IV. the chemical precipitation works at London, Glasgow and Leeds are described.

It will be noted at once that these important works of various types embody a majority of those at which during the past dozen years tests and investigations on a more or less elaborate scale have been made, and the results of which for the most part have been made public in considerable detail. In many instances the works include those of quite recent construction.

This book is essentially practical in its nature, recording the leading features of existing works with very few references indeed to theories or to analytical results such as have been set forth at great length in various reports made in recent years in England, and which are so characteristic of nearly all of the English books on the purification and disposal of sewage appearing since the last (1894) edition of "Sewage Disposal Works," by the late Santo Crimp. It is not to be inferred, however, that this book gives no clue to the character of the sewage treated at the various works, nor the degree of efficiency obtained. The population connected to the sewerage system and the volume of sewage, both during dry weather and storms, are generally stated, and comments are made as to the character of the various effluents. To those who study and summarize comparatively the current analytical data showing in more precise terms the efficiencies accomplished by some of the English works, this book will be of much assistance in making more intelligible the detailed data available from other sources.

No drawings, diagrams or other illustrations are to be found in this work. This is a feature which some municipal officers who will read the book only for general information may regret, but, on the other hand, typical plans and reproductions of working drawings in large number can be secured without much difficulty from English technical journals and official reports. After all, in the design of works for the purification of sewage there is very little which cannot be readily grasped after reading careful descriptions of the essential features of the works as built.

The designing and constructing engineer will find many features of much suggestive value in the descriptions given, as to the size and arrangement of screens used in various places; relative dimensions and capacities of tanks for sedimentation, chemical precipitation and septic treatment; rates of filtration, sizes of material found most successful in contact beds and percolating filters; piping arrangements and dosing devices; and actual experiences obtained in the treatment of storm flow. Construction costs are mentioned in seven instances and operating costs in five cases.

In most instances reference is made to the historical development of these sewage works up to the present time. Although of necessity in a book of this size the historical aspect is brief, a good idea is obtained as to the sequence and general nature of the more important events. Foot notes contain references to official reports and papers giving further particulars.

A perusal of this book suggests the belief held by many that in some places in England engineers on the one hand and the chemists and bacteriologists on the other have worked independently to a large extent, and not sufficiently in unison to make the data obtained as conclusive as desired. Neither elaborate tests as to efficiency alone, without regard to costs of construction and operation, nor the cost factors from well built and well managed plants alone, without reliable records as to capacity and efficiency, can put the subject on a definite permanent basis, and beyond the disturbing influences of differences in general opinions. The two lines of evidence require to be carefully associated and balanced. In this way the individuality of local conditions will become established and it will become apparent that in neither England nor America is there one procedure or one set of procedures best adapted to a wide range of conditions.

As is to be expected under existing circumstances, where on the same drainage area quite dissimilar plants have been built for the purification of sewage under fairly similar conditions, this book does not point out what might be called "the best method of sewage purification" under any given conditions. It does show, however, that there are several ways by which non-putrescible effluents may be obtained; and it sets forth many of the leading features of the large fund of valuable information upon this subject which has recently been obtained abroad. The author gives a brief summary of the prevailing tendencies in Great Britain, as exhibited by current practice, and this resumé appears to be as judicious and to be carried as far as it can well be done at this time.

The introduction records the general impressions obtained by the author as regards the influence of the Local Government Board, which (except in cases of Acts of Parliament) passes upon the practicability and adequacy of sewage disposal projects preliminary to the authorization of bond issues, and gives a number of very interesting comparisons between the conditions as to soil, climate, etc., obtaining in Great Britain and America. The author properly commends the Local Government Board for its conservative attitude regarding what may be called new methods—in the absence of conclusive [illegible] as to their merits. On the other hand, there [illegible]pointed out the absence of a guiding hand ex[illegible]ed by the Board to assist in solving satisfact[illegible] these problems under various local conditio[illegible] This task appears to be engaging the attenti[illegible] of the Royal Commission on Sewage Disposal [illegible], which has been sitting since May, 1898. Taking e[illegible]thing into consideration, it is questionable if [illegible]re is any better procedure than that of ha[illegible] the English municipalities investigate these [illegible]atters themselves under the local conditions wh[illegible] they have to face, and as many of them ha[illegible] done most creditably. It would then seem t[illegible]main for the Local Government Board pro[illegible]y to satisfy itself by such procedures as it s[illegible] fit as to the merits and reliability of each [illegible]roject presented.

This book is well gotten out, and it ha[illegible] good index. It is a valuable reference book f[illegible] those engaged in this line of professional work, and it should do much good in promoting info[illegible]ation among sanitarians generally in America i[illegible] regard to the manner in which large problems i[illegible] Great Britain have actually been met.

*Of Hering & Fuller, Consulting Engineers, 170 Broadway, New York City.

High Potential and High Frequency Currents.

EXPERIMENTS WITH ALTERNATE CURRENTS OF HIGH POTENTIAL AND HIGH FREQUENCY.—A Lecture Delivered Before the Institution of Electrical Engineers, London. By Nikola Tesla. With an Appendix by the Same Author on the Transmission of Electric Energy Without Wires, Reviewing his Recent Work, and Presenting Illustrations from Photographs Never Before Published. With a New Portrait and a Biographical Sketch of the Author. New edition. New York: McGraw Publishing Co. Cloth; 5½ × 7½; pp. 162; 40 figures in the text.

The lecture which forms the main portion of this little book was delivered twelve years ago. It is the presentation of a series of experiments which were fascinating, almost startling, at that time, and which to-day still have much of that character. The field which Tesla fringed in his work of that period has not been cultivated since, except that upon a small corner of it has been grown the science of wireless telegraphy. Almost as much interest, then, should lie in the lecture to-day as at the time of its original presentation. Unfortunately, it is difficult to *print* (with any degree of effectiveness) a lecture composed mainly of experiment-demonstrations, even when great trouble is taken to make suitable illustrations. In the present case practically no such trouble has been taken; in appearance and execution of both text and illustrations the book is very poor. An indication of this carelessness is that there is nothing in the book to say when the original lecture was delivered.

An appendix gives some of Mr. Tesla's more recent work in space-telegraphy. It tells briefly and vaguely of the author's experiments at Colorado Springs, Colo., in 1899, and of how he discovered stationary electirc waves surrounding a lightning storm. He promises, as a development of this discovery, to transmit power and intelligence all over the world, in unlimited amounts. This appendix brings little in the way of information.

ACCIDENTS AND EMERGENCIES.—A Manual of the Treatment of Surgical and Medical Emergencies in the Absence of a Physician. By Charles W. Dulles, M.D., Surgeon to the Rush Hospital, Philadelphia. Sixth Edition, thoroughly revised and enlarged. Philadelphia: P. Blakiston's Son & Co. Cloth; 5 × 7 ins.; pp. 209; frontispiece and 44 figures in the text. $1 net.

Some such book as this may prove invaluable to any field party or family, particularly if some member of one or the other follows the author's suggestion and reads the book carefully at least once and then keeps it at hand for reference in case of emergency. Among the emergencies treated which are liable to occur to engineers and contractors and their men are the various effects of intense heat or cold; accidents due to electric currents, to railway travel and to the operation of machinery; wounds and bites of various sorts, and poisoning. What to do under these and many other circumstances is plainly stated. Where helpful, as in directions for bandaging and for stopping the flow of blood from wounds, illustrations are freely used. There are about fifteen pages, including illustrations, on poisonous plants. There is also a long section on various domestic

emergencies, which term is made sufficiently elastic to include corns, mosquito bites and water purification. The latter subject, as well as disinfectants, might with profit have been somewhat more fully treated, but the space occupied is well used. Certainly boiling water for half an hour is both simple and effective, but it would not be advisable to dose all waters with six grains of alum per gallon. For emergencies it might sometimes be well to use so much alum, but in regular practice it would be wasteful and might be harmful, since waters deficient in alkalinity would not decompose all the alum. The excess would, of course, be useless, and some of it might be taken into the human system with the water and lead to derangements of the digestive organs.

Under "Supplies for Emergencies" there are given the contents of an emergency case, with instructions for its use.

Stream Measurements, Floods, Underground Waters and Water Pollution.

WATER SUPPLY AND IRRIGATION PAPERS, U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. F. H. Newell, Chief Engineer Hydrographic Branch. Washington, D. C.: Pub. Doc. Paper; 6 × 9 ins.

No. 95: Accuracy of Stream Measurements (Second, Enlarged Edition, replacing No. 64). By Edward Charles Murphy. Pp. 169; tables, six plates and 59 figures in the text.

No. 96: Destructive Floods in the United States in 1903. By E. C. Murphy. Pp. 81; tables, 13 plates and two figures in the text.

No. 101: Underground Waters of Southern Louisiana. By Gilbert Dennison Harris. With Discussions of their Uses for Water Supplies and for Rice Irrigation. By M. L. Fuller. Pp. 98; tables, 11 plates and 15 figures in the text.

No. 102: Contributions to the Hydrology of Eastern United States, 1903. By Myron L. Fuller, Geologist in Charge. Pp. 522; tables.

No. 103: A Review of the Laws Forbidding Pollution of Inland Waters in the United States. By Edwin B. Goodell. Pp. 120.

No. 104: Underground Waters of Gila Valley, Arizona. By Willis T. Lee. Pp. 71; tables, five plates and nine figures in the text.

Paper No. 95 (old No. 64) has been enlarged by 70 per cent. to include further experimental studies at the hydraulic laboratory of Cornell University, and also several series of actual stream gagings. A large part of the new matter is devoted to low-water measurement of streams in New York and California, and to vertical velocity measurements on Southern rivers, in the Catskills (New York) and on ice-covered streams. The old matter gives the results of earlier experiments at Cornell and elsewhere, and reviews the various methods employed in measuring streams. The bulletin is one of the most valuable in the series.

In Mr. Murphy's second paper (No. 96) he describes the floods at Heppner, Ore., and also in both South Carolina and Kansas and vicinity. The rainfall, stream flow and lessons to be drawn are discussed in each case. Earlier papers (Nos. 88 and 92) described the Passaic floods of 1902 and 1903.

Papers 101 and 104 follow the same general lines as earlier ones on underground waters. Interesting features of these two papers are the statements regarding rice irrigation in Louisiana and irrigation on an Indian reservation in Arizona.

Paper 102 is largely statistical. Besides a general review, it contains notes by 23 geologists on the wells, springs and general water resources of 17 states.

Mr. Goodell's paper (No. 103) will doubtless have the wide and hearty welcome which it deserves. After a brief review of the principles and leading decisions controlling water pollution, the author devotes about a hundred pages to quotations and abstracts of state legislation against water pollution classified under states with (1) partial, (2) general and (3) severe restrictions. Statutes of 44 states are cited. Of these 44 states, Connecticut, Massachusetts, Minnesota, New Hampshire, New Jersey, New York and Vermont are credited with severe restrictions. Ohio is classed with the states having only general restrictions, and the statutes cited come properly enough under that head. Whether by legislative authority or otherwise, Ohio actually stands in the first rank of those states which are intelligently guarding the public health by protecting public water supplies. Plans for both municipal water supply and sewage disposal are submitted to the State Board of Health for approval, and it seems to have veto power over such plans. Doubtless that power is given in some statute overlooked by the compiler of these citations.

Mr. Goodell's paper should serve as an encouragement to the states that have successfully grappled with the water pollution problem and as a stimulus to those that thus far have only dallied with it. Some of the latter have not yet gone beyond legislative enactments forbidding putting poison, or in some cases, dead animals, in wells and springs.

Evaporation, Condensation and Cooling.

Reviewed by Storm Bull,* M. Am. Soc. M. E.

VERDAMPFEN, KONDENSIEREN UND KUEHLEN—Erklärungen, Formeln und Tabellen für den Praktischen Gebrauch. By E. Hausbrand, Chief Engineer for C. Heckmann, Berlin. Third Edition. Revised. Berlin: Julius Springer. Cloth; 6 × 8 ins.; pp. 400; 76 tables and 21 figures in the text.

This book treats, as the title shows, of several subjects which, however, are more or less closely related: the evaporation, condensing and cooling of vapors and fluids, subjects which are constantly met with in practice, especially by mechanical and chemical engineers. The treatment is very thorough and goes into the minutest details so that there can hardly be imagined a problem for which the author has not given a solution. The complete theory of the various cases is first given, then practical formula are deduced and finally very extensive and useful tables based upon these formulas are given. In addition to these latter, a number of tables contain experimental data which of course have been made use of in establishing the practical formula. The book is therefore one which the practising engineer will find very useful, but it is not one which can be made use of in technical schools except as a book of reference. For American engineers the most serious objection to its use is the metrical units employed in both formulas and tables. The reviewer is also of the opinion that the book would have been still more useful if it had contained a number of illustrations of modern evaporators, condensers and coolers. As it is, the figures contained in the book are simply schematic outlines of objects or are diagrams to go with the mathematical demonstrations.

The first seven chapters of the book treat of the transmission of heat under various circumstances: by parallel and counter current; by direct fire; by means of saturated and superheated steam; by means of hot fluids, etc. Then follow chapters on the evaporation by means of saturated steam, contained in pipes, vessels with double bottom and in multiple-effect evaporators. In several chapters the question of how the motion of the steam and vapors is affected by drops of fluid is considered, and two chapters treat of the necessary widths of pipe lines for saturated steam, alcohol vapors and air. Then follows a chapter on the heat losses from apparatus of this kind as well as from pipe lines. Under the head of condensers separate and detailed treatment is given of the ordinary jet condenser, the dry and wet air pump, the surface condensers, both for air and water as condensing medium. The tables accompanying each subdivision are very complete, both as to the probable results under various circumstances and as to the necessary dimensions to obtain desired results.

The subject of cooling a fluid is considered under a variety of heads, such as by ice, by mixing with a cold fluid, by partial evaporation, by a cold fluid through a metal wall either in parallel or counter current, and by cold air through a metal wall or directly.

Three chapters at the end of the book treat especially of the various kinds of air pumps, their efficiency, the vacuum which may be obtained and the quantity of air which must be pumped out to obtain a certain vacuum.

In conclusion, the reviewer desires to state that he knows of no other book which contains such a comprehensive treatment of the subjects discussed, and that consequently this one deserves to be widely used by our practising engineers.

*Professor of Steam Engineering, University of Wisconsin, Madison, Wis.

A Valuable Monograph on Wave Action.

WAVE ACTION IN RELATION TO ENGINEERING STRUCTURES.—Professional Papers of the Corps of Engineers, U. S. Army, No. 31. By D. D. Gaillard, Major, Corps of Engineers. Washington, D. C.: Pub. Doc. Cloth; 6 × 9 ins.; pp. 232; tables, half-tone and other plates.

Not since the publication of Stevenson's "Construction of Harbors," in 1864, has so valuable an addition been made to the knowledge of wave action as is contained in this monograph by Major Gaillard. The tabulated and analytical results of more than 2,000 observations on waves and wave action, made by Major Gaillard, are certainly entitled to rank, in point of practical importance, with Stevenson's studies.

The monograph should receive commendation, if it were only for the excellent summary of old data bearing upon the subject of wave action; but the original investigations have in themselves so much merit that one is certain to hurry through the reading of matter that is old to get at the new.

The dynamometer experiments, which have been made on the coast of Florida and on the Great Lakes, are in themselves of great value; but, perhaps of more value still are the experiments made to show that the impact of moving water is in no way analogous to the impact of a solid body. Major Gaillard has demonstrated conclusively that the sudden impact of a jet of water, or of a mass of falling water, can produce no greater pressure than would be caused by a steady flow of water with the same velocity. Furthermore, that the pressure due to a steady stream of water is always less, but only slightly less, than the theoretical pressure due to its head.

It is impossible in a brief review to point out the character of all the original matter contained in this valuable monograph; but enough has been said, perhaps, to indicate that any engineer having structures to build that will be subjected to wave action should have at hand a copy of this admirable "paper."

POOR'S MANUAL OF THE RAILROADS OF THE UNITED STATES.—37th Annual Number, 1904. New York: Poor's Railroad Manual Co. Cloth; pp. xvi. + 1,435; tables and colored maps. $10.

"Poor's Manual" has come to hold about the same place in the financial world that the dictionary holds in the world of letters. It is the universally used reference work of unquestioned authority. The present edition is smaller by about 300 pages than the edition of 1903, on account of the omission of the tables of dividends paid, the dates of annual meetings and locations of transfer agencies, which are to be published hereafter in "Poor's Ready Reference Bond List," and the list of operating officers, which is also to be separately published hereafter as "Poor's Directory of Railroad Officials." The bulk of the book (about 845 pages) is made up of the detailed statements of operating steam railway companies, but the department of city and suburban railways now occupies nearly 300 pages, the department of industrial corporations over 100 pages and the record of State and municipal indebtedness about 100 pages more.

The Introduction contains statistical tables which must cost the publishers a very large sum for their compilation and are a most commendable piece of enterprise. A few of these tables of most interest to engineers are reprinted in the main portion of this issue.

VAPORISATION.—Etude Theorique et Pratique. Methode pour augmenter considerablement le rendement des generateurs a vapeur. By M. E. Wickersheimer, Chief Engineer of Mines. Paris: Vve Ch. Dunod. Paper; 6½ × 10 ins.; pp. 76; tables and figures in the text.

The author makes an extended argument in favor of a special process of protecting boilers against corrosion. This process is the employment of William's liquid, composed of tannin, barium chloride and glue; in France it is promoted as the Bez process. The author argues for the addition of inorganic salts to boiler feed water for the purpose of regulating the evaporation and increasing the efficiency of the boiler. Chloride of calcium is recommended.

Kidder's Architects' Pocket-Book.

ARCHITECT'S AND BUILDER'S POCKET-BOOK.—A Handbook for Architects, Structural Engineers, Builders and Draftsmen. By Frank E. Kidder, C. E., Ph. D., F. I. A., Consulting Architect and Structural Engineer, Denver, Colo.; Author of "Building Construction and Superintendence." Fourteenth Edition, Rewritten. New York: John Wiley & Sons. London: Chapman & Hall. Leather; pp. xix + 1,656; 1,000 figures in the text. $5.

Great courage on the part of author and publisher alike is required to keep a professional "pocket-book" abreast of the times. In revising his well-known work for the fourteenth edition, Mr. Kidder found it advisable to rewrite a large proportion of the book and to add much new matter. The result is that we now have a volume of 1,655 pages for architects which is worthy of a place with Trautwine's similar book for civil engineers and Kent's for mechanical engineers. The large type employed adds greatly to the ease of using the book. The bulkiness of the volume is of less consequence for architects than it would be for engineers, since the former have comparatively little occasion for carrying about the country their chief book for reference.

Of the general scope of the book, little need be said except that it is very comprehensive in character and seems to include nearly everything an architect needs to know and that could be compressed into one handy volume. Between 800 and 900 pages are devoted to "Strength of Materials and Stability of Structures." There are also sections on heating, ventilation, chimneys, plumbing, gas-piping, illumination and electrical subjects. A glossary of technical terms and a collection of legal definitions are given. Details of practice and references to the literature of the subjects discussed are abundant.

Some of the space on steel trusses and steelwork might have been used to more advantage for other subjects, such as the timber frame construction, so common in the United States, and important details, like cornice construction for city buildings.

The brief mention of water purification for isolated buildings might well have been extended and a reference given to the literature of the subject. At least a brief section, with references to sources of further information, might well have been devoted to sewage disposal for country houses. The page on smoke prevention, which treats the subject wholly as though it were a matter of furnace accessories, would have been vastly more valuable had there been added even a single sentence indicating that the fundamental principles of smoke prevention are the proper design and firing of the furnaces.

Concrete piles and the use of reinforced concrete for columns are not mentioned. Reinforced concrete for floors is presented fairly well.

Under "Artificial Cements," pp. 194-7, opportunity for a number of minor but justifiable criticisms is afforded: (1) The author says there are three varieties of Portland cement: true, silica or sand and slag. Sand and slag cements are in no sense varieties of Portland cement. (2) It is true that more than half the Portland cement used in this country is of domestic origin, but the statement would be more exact and significant if the author had said more than 90%. (3) The standard of fineness for Portland cement is placed too low. Instead of specifying that not less than 95% of the cement shall pass through a sieve of 2,500 meshes per sq. in., the general practice now is to require that at least 90% shall pass through a 100-mesh (10,000 per sq. in.) sieve. The author states, however, that the U. S. Corps of Engineers requires that 92% shall pass through a sieve of the latter fineness.

One other criticism of what the author says on cements is typical of his practice throughout the book. He names a few brands of cement as "among the leading brands," but those mentioned are no better than a dozen others. In the brief section on water purification one manufacturer only is mentioned. Obviously, an author labors under a difficulty and is in danger of having his motives misunderstood when he cites one or a few out of many manufacturers of a product. Mr. Kidder states in his preface that he has given the names and addresses of manufacturers solely for the benefit of the users of his book, and we believe him; but there is nevertheless an element of unfairness to unmentioned manufacturers and danger of misleading readers in presenting only partial lists.

Our final criticism refers to the omission of dates in the citation of building and plumbing ordinances. In many other citations dates are given. The frequency of amendment of city ordinances makes it desirable to know the dates of those cited.

JOURNAL OF THE IRON AND STEEL INSTITUTE. —No. 1, 1904. London: E. & F. N. Spon, Ltd. New York: Spon & Chamberlain. Cloth; 6 x 9 ins.; pp. 768; illustrated.

JOURNAL OF THE IRON AND STEEL INSTITUTE.—Supplement to Vol. XLV.—Relations Between the Effects of Stresses Slowly Applied and of Stresses Suddenly Applied in the Case of Iron and Steel: Comparative Tests with Notched and Plain Bars. By Pierre Breuil. London: E. & F. N. Spon, Ltd. New York: Spon & Chamberlain. Cloth, 6 x 9 ins.; pp. 150; 22 plates and 60 figures in the text.

Papers and discussions on various phases of the manufacture of iron and steel occupy 460 pages of the first of these volumes. Then follow the excellent references to and abstracts of the current literature for the year, which form a part of every volume of the Journal of the Iron and Steel Institute. Iron ores, fuel, iron mining, mechanical and metallurgical preparation, refractory materials, gas, coal mining, washing and screening, pig iron production, steel production, chemical analysis, and statistics, form the main heads under which the literature is reviewed.

Among the original papers and discussions the following may be mentioned: "Notes on the Production and Thermal Treatment of Steel in Large Masses," by C. Johns; "The Manufacture of Coke in the Hüssener Oven, at the Clarence Iron Works, and its Value in the Blast Furnaces," by C. Lowthian Bell; "The Synthesis of Bessemer Steel," by F. J. R. Carrilla; "The Thermal Efficiency of the Blast Furnace," by W. J. Foster; "The Plastic Yielding of Iron and Steel," by W. Rosenhain; "The Use of Steel in American Lofty-Building Construction," by B. H. Thwaite; "The Influence of Varying Casting Temperature on the Properties of Steel and Iron Castings," by P. Longmuir.

The supplementary volume describes the work carried out by Mr. Pierre Breuil while holding an Andrew Carnegie Research Scholarship of the Iron and Steel Institute. The memoir, as it is termed, was considered so meritorious that the Council of the Institute awarded to the author the gold medal for 1904.

The elaborate tests conducted by the author led him to draw the important conclusion that "A slow action produces the same effects as a sudden action upon metal." It is therefore preferable to adopt tests of the former type, rather than tests of the latter type, since the first named are more exact.

The author also shows that tensile and bending tests upon nickel bars are not so reliable as a test upon plain bars, for the slightest variation in the manner of nicking produces remarkable variations in the results of the test. An abstract of the memoir is published in the regular volume of proceedings. noted above.

AMERICAN WATER-WORKS ASSOCIATION.—Proceedings of the Convention Held at St. Louis, Mo., June 6 to 11, 1904. Elmira, N. Y.: J. M. Diven, Secretary. Paper; 6 x 9 ins.; pp. 585; many illustrations, mostly on folding plates.

The group of papers on water meters and on meter rates, together with the accompanying discussion, is a notable feature of this report. The papers mentioned include one by Mr. John B. Heim, of Madison, Wis., on "Meter Rates"; one by Mr. F. C. Kimball, recently of Knoxville, Tenn., on "Equity of Minimum Charges for Meter Services"; one by Mr. E. W. Bemis, on "The Meter System in Cleveland," and one by Mr. Park Woodward, of Atlanta, Ga., on "Meters; Their Use and Benefit." The paper by Mr. Bemis deals with the rapid introduction of meters in that city and gives some interesting information regarding the freezing of meters set in sewer pipes, brick vaults and in basements during the unusually cold winter of 1903-4.

A unique contribution to water-works literature presented in this report is the exhaustive paper, of 80 pages, on water hammer. A large p[art] of this paper is taken up with an account of [the] study and experiments on water hammer made [by] Prof. N. Joukovsky. In the discussion of Mr[.] Smith's paper, it was characterized by Mr. Rud[olph] Hering as "the best contribution we have on [the] subject of which it treats." Papers by Mr. [Wil]liam R. Hill, M. Am. Soc. C. E., on changes in [the] plans of the New Croton Dam, and by Mr. D[e] Witt H. Maury, on recent developments in w[ater] and pumps, were presented in Engineering [N]ews shortly after the convention. Another p[aper] deserving mention is one by Mr. Dow R. G[ale], of Terre Haute, Ind., embodying a large num[ber] and variety of forms used by the Terre Haute [Water] Works Co. for its records and accounts. A[n] illustrated paper of some length, on "Water [Service] at the Baltimore Fire," by Mr. Alfred M. [Quick], will be welcomed by those who have occ[asion] to study large conflagrations and their rela[tion] to water supply. Many other subjects of p[rac]tical value are discussed in the report, which, a[s] usual of late, has been issued with comm[enda]ble promptness and in good form.

NEW YORK STATE ENGINEER AND SURV[EYOR].—Report for the Year Ending Sept. 30, 1903. Ed[ited] by A. Bond, State Engineer. Albany, N. Y.: Pu[b.] Doc. Cloth; 6 x 9 ins. (two volumes); pp. 508 a[nd] 336, folding and other plates, including maps.

The present status of the Barge Canal work is summarized in the first 60 pages of the first volume of this report. Then follows a large folding table giving in condensed form the data relating to the highway improvement thus far done, the width, depth and character of metalling being given, as well as the contract price per mile etc. Following this is another valuable table giving the results of road laboratory tests on nearly 50 specimens of rock from different parts of the state.

The reports of the three division engineers give further details as to the road construction and the progress of work. Then come 80 pages giving fac-simile copies of certain old field notes and maps, copies of which have often been called for and are now available. These ancient field notes and maps are also published in pamphlet form for free distribution.

In the second volume the results of stream measurements throughout New York State are given. These measurements were begun in 1901 and have been increased in number from year to year, so that the information is yearly growing in value. In this volume, also, are given the results of the cooperative topographical survey of the State. There is added a reprint of the "Instructions for the U. S. Geological Survey Work." Heretofore these instructions have been published only in pocketbook form for the use of the engineers in the field, but they are here made available for general use. These instructions will be found very useful to any engineer having topographical work to do, for they are clear, compact and practical.

THE USES OF HYDRAULIC CEMENT.—By Frank Harvey Eno, C. E., Associate Professor of Civil Engineering, Ohio State University, Columbus, O. Geological Survey of Ohio. Edward Orton, Jr., State Geologist. Fourth Series, Bulletin 2. Columbus, O.: Pub. Doc. Paper; 6½ x 10 ins.; pp. 260; tables and 157 figures in the text.

This is one of two bulletins relating to the cement industry that have been in preparation for some time under the direction of the State Geologist of Ohio. The present bulletin is to be followed by one on the technology of cement manufacture.

Professor Eno has divided his discussion into five chapters, with the following titles: Brief History of Cement; Uses of Cement in Mortars; Uses of Cement in Concrete; Uses of Cement in Reinforced Concrete; Specifications for Concrete Materials; Machinery and Tools. The general method of treatment has been to give in each chapter a list of uses and to explain and exemplify each by descriptions and illustrations of representative works. Naturally the collection is rather miscellaneous in character, but this is perhaps an advantage on the whole, since the purpose is admittedly that of acquainting the general public with the wide possibilities of cement in all classes of construction.

Steam Boiler Tests with Liquid Fuel.

Reviewed by Prof. Wm. Kent,* M. Am. Soc. M. E.

REPORT OF THE U. S. NAVAL "LIQUID FUEL" BOARD.—Tests Conducted on the Hohenstein Water Tube Boiler, Showing the Relative Evaporative Efficiencies of Coal and Liquid Fuel Under Forced and Natural Draft, as Determined by an Extended Series of Tests Made by Direction of the Bureau of Steam Engineering, Navy Department. Washington, D. C.: Gov't Doc. Paper; 8 x 11¼ ins.; pp. 450; many tables and 114 figures, including some on folding plates.

This report describes in complete detail a series of experiments which were made between April, 1903, and June, 1903, on the use of Beaumont Texas oil as a fuel for steam boilers.

In order to establish a standard of comparison 17 tests were first made with Pocahontas and New River coal at different rates of driving, viz., from 8.38 to 14 and 15 lbs. of water evaporated per square foot of heating surface per hour. The results of these tests gave an evaporation from and at 212° F., ranging from 9.52 to 11.77 lbs. of water per pound of combustible. The efficiency of the boiler ranged from 59.4 to 73.4, and the efficiency of the boiler and furnace from 54 to 68.3%. The coal burned per hour per square foot of grate surface ranged from 18.5 to 72.2 lbs.

The fuel oil tests were 69 in number. They were made with a great variety of burners of different types. The names of the burners used are as follows: Oil City, Hayes, Reed, Advanced, Branch, Best, Harvey, Santa Fe, and McDonald. Most of these burners used steam as the spraying agent, but some used air and one used both air and steam. The duration of the tests was from two to eight hours except one endurance test, which ran 116 hours. The following table shows the range of conditions under which the tests were made.

Draft pressure in furnace from 0. to 3.75 ins.
Draft suction in stack, —.05 to —.061 ins.
Temperature of chimney gases, 449 to 1053°F.
Moisture in steam, 0.2 to 2.5%.
Equivalent evaporation from and at 212 degrees per pound of oil, 9.52 to 14.43 lbs.
Pounds steam used in spraying, per pound of oil, .153 to 1.231.
Pounds of steam used in spraying oil, per pound of steam generated, 1.06 to 10.81.
Pounds oil per hour per horizontal square foot of furnace, 14.36 to 65.9.
Pounds of oil per hour per square foot of heating surface, .28 to 1.39.
Equivalent evaporation, pounds of steam per hour per horizontal square foot of furnace, 166 to 709.
Equivalent evaporation, pounds of steam per hour per square foot of heating surface, 4.61 to 16.7.
Carbon dioxide in chimney gases, 4.6 to 10.1.
Oxygen in chimney gases, 6.64 to 13.05.
Carbon monoxide, 0. to 2.1.
Efficiency of boiler, 49.2 to 71.5%.

It will be observed that the rate of driving of the boiler in both the coal and oil tests ranged all the way from what is a fairly rapid rate for land purposes up to the most extreme rate of rapid driving in the naval service. An evaporation of 14.15 lbs. of water per square foot of heating surface per hour is about the maximum that is ever obtained with coal firing and the 16.7 lbs. which was obtained in oil firing is probably the highest figure on record.

The oil used in the tests analyzed as follows: C, 83.2; H, 12.41; S, 0.50; O, 3.83. Specific gravity, 9.26; Flash point, 216; Fire point, 240°F.; Evaporization point, 142° F. Loss for six hours at 212°, 21.65%. Calorimetric value by analysis, 19,481 B. T. U. per lb. This was an oil treated to remove the sulphur and some of the hydrocarbons. The crude oil contained C, 84.6; H, 10.90; S, 1.63; and O, 2.87.

The boiler used in the tests was a Hohenstein boiler, made with horizontal steam and water drums and inclined tubes set in a firebrick furnace with a firebrick roof. The furnace was well adapted for burning either oil or semi-bituminous coal. Forced draft was furnished by a Root blower. The boiler had 2,130 sq. ft. of heating surface and 50 sq. ft. of grate. It was able to conform to the requirements of weight, capacity and space occupied by one unit of the boiler installation of cruisers of the Denver class. Each such unit is required under forced draft of 1 in. water pressure, and 275 lbs. steam pressure, to evaporate 12,000 lbs. of water per hour under actual steaming conditions. On the basis of 16 lbs. of water per I. HP. per hour there would thus be developed for main engines and circulating pumps about 15 I. HP. per hour per square foot of grate surface, a requirement that is not exceeded by any other installation of straight large type tube of boiler in the United States Navy.

A most elaborate plant was fitted up at the Washington Navy Yard. The observations were all made by officers of the U. S. Navy. The report seems to have been made with exceeding care, and a very thorough study of the results of the tests is given together with numerous drawings of the various kinds of burners used. One highly satisfactory chapter of the report is devoted to the classification of oil burners, in which clear line drawings are made of all of the different classes and their principal modifications. It is safe to say that no other report on oil burners conveys anything like the amount of information that this one does.

As the result of the tests with coal the Naval Board says:

The result of the capacity tests of the experimental boiler conclusively showed that naval administrators will be justified in prescribing that all straight-tube naval boilers should be required to burn at least 40 lbs. of coal per square foot of grate per hour under forced draft, and that in order to effect such a rate of combustion the limit of air pressure may be allowed to reach 2½ to 3 ins. By reason of the practical ability to secure increased coal combustion in marine boilers of the water-tube type the maximum I. HP. now required of each square foot of grate surface should be increased.

The Board also quotes at length from the report of the Engineer-in-Chief of the Navy, Rear-Admiral George W. Melville, for the year 1902, concerning the problem of the water-tube boiler. We repeat here a few of his most important sentences.

The present problem of the modern battleship is not that of the gun and its mount, but the boiler and its installation. The agitation in Great Britain over the navy-boiler question ought also to convince naval administrators that the boiler problem is the naval problem of the hour.

The fact may not be appreciated in its fullness at the present time, but the experience of the coming five years with the ships nearing completion will conclusively show that in coming naval conflicts the question of victory may be quite as much dependent upon the battle of the boilers as the contest between the guns.

In this report Admiral Melville comments on the tests and on the boiler used, as follows:

In many respects the experimental plant was one of the most complete that has ever been established. The series of tests conducted will command attention in the engineering world, for absolute information has been obtained as to the evaporative efficiency and endurance of the boiler. Information has also been secured in regard to the best means of baffling the gases, thus increasing the evaporative efficiency as well as permitting the boiler to be forced for emergency purposes. Particular care has also been given by the board to the investigation of the circulation of the water, for probably the key to the boiler problem is the question of circulation. . . . In view of the present condition of this experimental boiler after eighteen months of use with both coal and oil as a combustible, considering the results secured, and by reason of the report submitted by the board which conducted the series of tests, the Bureau has no hesitation in regarding the boiler as the equal in efficiency and endurance of any used in a foreign battleship.

In addition to the reports of the tests of the Hohenstein boiler the report includes a study of results of tests of oil fuel on the S. S. Mariposa, S. S. Alameda and S. S. Nebraska. It also has a chapter on use of oil in locomotives, one on the mechanics of combustion as especially related to using liquid fuel, and another on mechanical burners for spraying, which work without the aid of any intermediary agent such as steam or compressed air. Other chapters are devoted to furnace construction, relative prices of oil and coal, and limitations in the use of oil fuel. In a chapter on the smoke nuisance it is said that although the Board had the advice and assistance of the most experienced fuel experts in the United States in devising means to secure complete combustion never in the experience of many citizens of Washington had such clouds of smoke been seen coming from a chimney as were issued from the boiler-stack of the experimental plant when oil tests were conducted under strong forced draft conditions.

The final chapter of conclusions regarding the tests contains no less than 33 items. Only a few of these need be given here.

No difficulty is experienced by an intelligent fireman in handling oil.

Steam is not as satisfactory as air for spraying the oil.

Crude oil should not be used on account of the danger.

Combustion is improved by heating both the air and the oil.

Difficulty frequently arises from clogging of the oil burners.

Cheap labor cannot be employed in oil burning.

For marine work no crude petroleum should be used.

Under severe forced draft conditions and with water tube boilers with oil as fuel the solution of the smoke question is nearly as remote as ever.

In order to secure increased speed for warships, naval administrators are justified in demanding of manufacturers of water tube boilers increased coal consumption per square foot of grate surface.

Scotch and mica water gage glasses fail in boilers carrying over 250 lbs. pressure.

Fire-brick arches disintegrate either under the action of the intense heat generated or due to the action of the acids in the oil or coal.

Experiments to secure a more refractory brick are necessary.

There are many serious structural and mechanical difficulties in regard to the handling and transportation of oil upon ships of war. A commission should be authorized by Congress to formulate rules and regulations providing for an economical, efficient, enduring and safe oil fuel installation. Experiments should be made on the different forms of baffling in water tube boilers.

The engineering or mechanical or practical feature of the liquid fuel problem has been satisfactorily solved.

For manufacturing purposes the financial and supply features are the only hindrances to the use of oil as a standard fuel.

For mercantile marine purposes the commercial and transportation features of the problem limit the use of oil in merchant ships. For naval purposes there is the addition and serious difficulty to be overcome of providing a satisfactory and safe structural arrangement for carrying an adequte bunker supply.

The oil supply of the world is so limited that it cannot meet over 3% of the world's demand for coal and other fuels.

The report is signed by the members of the Board, namely, Commander John R. Edwards, U. S. N., and Lieutenant-Commanders W. M. Parks and F. H. Bailey, and approved by Rear-Admiral Melville.

On the whole it is one of the most satisfactory technical reports which has ever been issued by our Government. It practically settles the question of burning oil on ships of war in the negative, except as regards its use in a few vessels for cruising on the Pacific Ocean, with depots of supply in California and possibly Hawaii. The difficulty of procuring oil in different parts of the world is an effectual bar to its use on a battleship.

THE DETAILED DESIGN OF A RAILROAD BRIDGE.—By Wm. H. Burr and Myron S. Falk. Columbia University. Reprinted from School of Mines Quarterly, 1904. New York: As Above. Paper; 6 x 9 ins.; pp. 54; illustrated.

This pamphlet has been prepared to take the place of considerable matter in Chapter X. and Article 85 of the eighth edition of Prof. Wm. H. Burr's "Stresses in Bridge and Roof Trusses," and will ultimately form a chapter of the new edition now being written. As the title indicates, the pamphlet presents in detail the process of designing and detailing a railway bridge from assumed data, such as would be furnished an engineer by a railway company.

TESTS OF REINFORCED CONCRETE BEAMS.—By Arthur N. Talbot. Bulletin No. 1 of the University of Illinois Engineering Experiment Station, Urbana, Ill. Paper; 6 x 9 ins.; pp. 64; illustrated.

The general substance of this report was given by Professor Talbot in a paper published in our issue of Aug. 11. It presents very full information on an important series of tests. It may be noted also that this is the first bulletin issued by the engineering experiment station, which has been established as the result of action taken by the Board of Trustees of the University in December, 1903.

THE PASSENGER CAR VENTILATION SYSTEM OF THE PENNSYLVANIA RAILROAD CO.—By Charles B. Dudley, Chemist. Altoona, Pa.: Pennsylvania R. R. Co. Paper; 6 x 9 ins.; pp. 24; folding plates.

Besides describing the method of car ventilation now in use on hundreds of cars on the rail-

*Dean of College of Applied Science, Syracuse University, Syracuse, N. Y.

road named, Dr. Dudley gives a brief review of the literature of car ventilation and discusses some of the difficulties to be encountered in attempting to supply fresh air to railway passengers. An article based on this pamphlet appeared in Engineering News of Sept. 29, 1904.

Railway Shop Design and Equipment.

AMERICAN RAILWAY SHOP SYSTEMS. By Walter G. Berg, Chief Engineer, Lehigh Valley R. R. New York: The Railroad Gazette. Cloth; 6 × 9 ins.; pp. 198; 108 figures, including half-tones. $2.

The great amount of work which has been done by American railways within recent years in the remodeling of shop plants and the construction of new plants, not only for increased amount of work and heavier work, but also for increased facilities and economy in work, has led to a desire for information as to the principles and the governing conditions affecting shop design. Apart from articles in the technical papers, however, there has been very little information of this kind obtainable, and these articles usually deal more with individual shops than with general principles. The book before us is therefore very timely, although probably every reader will wish that there were more of it. The author states in his preface that particular attention has been paid to establishing "a special grouping and classification of shops, as an aid to an intelligent analysis and understanding of the subject." Of the 198 pages, the last 95 are devoted to illustrations, while some accessory matter, including a bibliography of articles in technical papers, reduces the general discussion of the subject to about 86 pages.

The classification of shops according to the character of their work is first outlined, with the evolution of the general plan, including the questions of power, lighting, and the handling of material. This is followed by a more detailed classification of shops according to their track arrangements. The author states that the tendency is towards the erection of very large single-story buildings with few dividing walls. The objection is sometimes made to large shops that the supervision of the work is more difficult than where the various sub-departments are grouped in separate buildings. The author does not consider this a serious objection, and notes that at a number of large shops (notably those of manufacturing concerns) the unit system has been introduced, since one man cannot take charge of a very large plant and it is well to have his assistants in charge of certain units of the plant. This method has been adopted in the great foundry (1,200 ft. long) of the McCormick reaper works and the foundry and erecting shops of the Allis-Chalmers Co. The dimensions of a number of large shops are given in the book before us.

Considerable space is given to discussions of the limits of transfer table service and the comparative merits of longitudinal or transverse track arrangements in locomotive repair shops. The latter is preferred for very large plants, a heavy traveling crane being used to lift engines laterally over other engines standing on the floor. The longitudinal shop with machine shop on one or both sides of the erecting shop has objectionable elements, but the latter is the preferable plan. The question of floor space is next taken up, and tables are given of the dimensions of shops on a number of railways, and the percentage of area occupied by different departments. As to the pit ratio in erecting shops, practice indicates that the number of pits is from 6 to 10 per cent. of the number of engines to be cared for; 8 per cent. is the average, and few roads maintain the desirable theoretical ratio of 10 per cent. It is usually assumed that every engine goes to the shop once a year for light repairs and once for heavy repairs, but in practice few roads are able to live up to this rule. Car repair shops and store houses are discussed in the same way, but in much less detail.

The important subject of power plant and machinery is then taken up, and it is shown that the economical plan is to concentrate all power plant machinery in one central power house, but a large equipment of steam saving appliances should not be used unless fuel is very costly. As to motive power, consideration must be given to the use of exhaust steam for heating, which is not available with gas engines or steam turbines. Ample machine equipment is the principal feature to ensure the prompt return of engines into service, but the author states that "on most railways the machine equipment at the shops is inadequate or antiquated; in this respect railway companies are far behind manufacturing plants." Attention is also called to the necessity of introducing labor-saving appliances to reduce the cost of handling heavy parts, not only in the erecting shop, but in the machine and boiler shops and in the yards. There is now a growing tendency to provide equipment of this class. The structural work of buildings, in regard to lighting, fireproofing, etc., is discussed. There are also notes on track and roadway facilities, and other auxiliary features.

Throughout the volume the treatment is analytical rather than descriptive, although brief descriptions of numerous shop plants are given to illustrate the various points made and to show the tendency of modern practice. The book is written in a simple and interesting style, and gives evidence of much thought and care on the part of the author. The illustrations are good, but several of the shop plans have been over-reduced, making it difficult to follow out the arrangement shown and to read the lettering.

MANUAL OF MODERN SURVEYING INSTRUMENTS AND THEIR USES.—Containing Useful Information for the Civil Engineer and Surveyor. Together with a Catalog and Price List of Scientific Instruments. Written and Edited by Otto von Geldern. San Francisco, Cal.: The A. Lietz Co., 422 Sacramento St. Heavy Paper with Cloth Back; 6 × 9 ins.; pp. 126, not including catalog section; illustrated. 50 cts.

As indicated by the above heading, this book is a combined catalog and manual of surveying instruments.

Following a description of the manufacture of surveying instruments, as conducted by the publishers of the catalog, the following professional papers appear: "A Short and Practical Treatise on Stadia Surveying," by Otto von Geldern; "Remarks on the Principle of the Logarithmic Slide Scale," by Hubert Vischer; "Some Practical Hints on How to Tell a Good Surveying Instrument," by A. Lietz; "The Goldschmid Aneroid," from Specht's description of the instrument; "A Short Method of Finding the Length of One Minute of Longitude in any Latitude," by Otto von Geldern; "The Saegmuller Solar Attachment," "The Cyclotomic Transit," by Otto von Geldern. The 46 pages taken up by these seven papers contain excellent matter well presented; the first paper, for example, includes a good table of stadia reductions for every two minutes of vertical arc up to 31°.

THE CLAYS AND CLAY INDUSTRY OF NEW JERSEY.—By Heinrich Ries and Henry B. Kümmel (State Geologist), Assisted by George N. Knapp. Vol. VI., Final Report of the State Geologist. Trenton, N. J.: Geological Survey of New Jersey. Cloth; 7 × 10 ins.; pp. xxvii. + 548; 56 plates, including maps in pocket, and 41 figures in the text. $1.35; or with photo relief map, $2.85.

This report is divided into four parts: Part I., Clay and its Properties; Part II., The Stratigraphy of the New Jersey Clays; Part III., The Manufacture of Clay Products; Part IV., The Economic Geology of the New Jersey Clays. The hundred or more pages of Part I. would constitute an excellent book by themselves, treating, as they do, of the mode of occurrence of clay, the methods of working clay deposits, the chemical and the physical properties of clay. Part III. contains 130 pages devoted to the manufacture of building brick, fire brick, tile, conduits, hollow ware, terra cotta, and the clay mining industry. In Chapter XI. of this part are given the results of tests made on New Jersey bricks, showing the compressive and transverse strengths and percentage of absorption. One exceedingly interesting generalization follows from these tests, and that is that the modulus of rupture bears no relation to the crushing strength, being practically the same for a stiff-mud brick having a compressive strength of 2,000 lbs. per sq. in. as for a stiff-mud brick having a compressive strength of 8,000 lbs. per sq. in. These tests, which so far as we remember are the most complete of their kind ever published in this country, were made by Prof. I. H. Woolson, of Columbia University.

Parts I., III. and IV. were written by Dr. Heinrich Ries, Assistant Professor of Economic Geology, Cornell University, and the general [illegible] of the entire report is acknowledged in the pr[illegible] to be his.

The report is well indexed and is acco[illegible]led by five large folding contour maps show[illegible] the clay deposits of New Jersey.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.—Proceedings of the Meeting at [illegible] June 27 to 29, 1904. Chicago: Jos. W. Taylo[illegible], Secretary. Half leather; 6 × 9 ins.; pp. 352; tab[illegible]ing plates and figures in the text.

MASTER CAR BUILDERS' ASSOCIATION.—Pr[illegible] of the Meeting at Saratoga, June 22 to 24, 19[illegible] cago, Ill.: Joseph W. Taylor, Secretary, 65[illegible] Building. Half leather; 6 × 9 ins.; pp. 584; [illegible] folding plates and figures in the text.

Examples of the good work done by the [illegible]way technical associations are furnished by th[illegible] two reports.

In the volume issued by the Master Mec[illegible]ics' Association, the reports are as follows: L[illegible]motive front ends; Piston valves; Axles and fo[illegible]gs; Automatic stokers for locomotives; Loco[illegible]tive frames; Cost of locomotive repair shops; P[illegible]ing locomotives and tenders; Boiler design; Ton[illegible]illeage of switching engines. Individual papers treat of the following subjects: Improved tool steel and the relation between tool, steel, motor drivi[illegible] and machine tools, by W. R. McKeen; Grates for bituminous coal, J. A. Carney; Technical school graduates in railway service, R. D. Smith; Terminals for locomotives, Robert Quayle; Variable speed motors, C. A. Seley. The principal topical discussions are as follows: Screw and hand reversing gears; Reducing the diameter and pitch of staybolts; Air spaces under locomotive grates; Leaky tubes in wide fireboxes; Lubrication of rod and driving-box bearings; Width of fireboxes for bituminous coal. In addition to the above there are specifications for boiler and firebox steel, air-brake instructions, instructions for conducting tests of locomotives, and drawings of the Association's standards.

The principal committee reports in the Proceedings of the Master Car Builders' Association are as follows: Tests of M. C. B. couplers; Location of third-rail for electrical operation; Draft gear; Air-brake hose specifications; Prevention of rust on steel cars; Repairs to steel cars; Tank cars; Outside dimensions of box cars; Cast-iron wheels. The topical discussions include the following: Effect of friction draft gear in reducing repairs and expenses; Side bearings; Stronger draft gear for passenger cars. There is a paper by Mr. Wm. Forsyth on "Steel in Passenger Car Construction," and there is also an address by Mr. Mosely, the Secretary of the Interstate Commerce Commission. About 300 pages are devoted to the reports, discussions and general proceedings. The rest of the volume is occupied by rules of interchange and arbitration cases, air-brake instructions, and the standards and recommended practice of the Association, together with 35 lithographed plates.

THE ARCHITECTS' DIRECTORY AND SPECIFICATION INDEX FOR 1904-5.—A Complete List of the Architects in the United States and Canada, Classified by States and towns, together with a Brief Specification Index of Prominent Dealers and Manufacturers of Building Materials and Appliances and a Complete List of Landscape and Naval Architects of the United States and Canada. Published Annually. Sixth Edition. New York: Wm. T. Comstock. Cloth; 7 × 10 ins.; pp. 151. $2.

The names and addresses of 5,736 architects, 97 landscape architects and 88 naval architects are given in this volume, together with an indication of the national architectural societies of which they are members. The names and officials of architectural societies are also given.

SELF-PROPELLED VEHICLES.—A Practical Treatise on the Theory, Construction, Operation, Care and Management of All Forms of Automobiles. By James E. Homans. New York: Theo. Audel & Co. Cloth; 6 × 9 ins.; pp. 652; tables, and 461 figures in the text. $2.

The first edition of this satisfactory book was reviewed in this Supplement for June 18, 1903, and there is little to add in reference to the present edition in the way of either explanation or commendation. It may be noted, however, that work of revision performed on the first edition has increased the size of the book some 28 pages. In conclusion, we will repeat our assertion in reviewing the first edition, that this is by all odds the most satisfactory book on self-propelling vehicles for road traffic that has come to our notice.

The Principles of Wireless Telegraphy.

Reviewed by Samuel Sheldon.*

MAXWELL'S THEORY AND WIRELESS TELEGRAPHY.—Part I. Maxwell's Theory and Hertzian Oscillations. By H. Poincare. Translated (from the French) by Frederick K. Vreeland. Part II. The Principles of Wireless Telegraphy. By Frederick K. Vreeland. New York: McGraw Publishing Co. Cloth; 5 x 9 ins.; pp. 235; 145 figures in the text. $2.

The first part of this book contains twelve chapters, in which Maxwell's theory of displacement currents and of the relations between light and electricity and the methods of production, detection and propagation along a wire, in air and in other dielectrics of Hertzian waves, are presented in a masterly manner. No mathematics are employed, and yet the style cannot be termed popular, for the treatment is logical, concise, precise and comprehensive. This part is an interesting and an instructive presentation of a theory and its subsequent experimental verification. It is suitable both for those who know and those who wish to know.

The second part, in six chapters, treats of the general principles of signaling through space; telegraphy by means of Hertzian waves; grounded oscillators and the propagation of grounded waves; microphonic, mechanical, thermal, electrolytic and magnetic detectors; and systems of selective signaling. The style is similar to that of the first part. The treatment is evidently not influenced by the patent situation, and is therefore an impartial one.

A Compact Text-Book on Alternating Current Machinery.

ALTERNATING CURRENT ENGINEERING.—Practically Treated. By E. B. Raymond, Testing Department General Electric Co. New York: D. Van Nostrand Co. London: Kegan Paul, Trench, Trübner & Co. Cloth; 6 x 8 ins.; pp. 232; 102 figures in the text. $2.50 net.

To teach the theory and practical working of alternating-current machinery in the most simple manner, yet thoroughly, is (we assume) the ideal of all electrical instructors. With this ideal before them, most writers of modern alternating-current text-books take hold of the iron-core solenoid, and, by explaining its properties in detail, aim to build up a strong concept of magnetic and electric interaction. A good deal is involved in this explanation—there are the properties of the magnet, per se, and the lines-of-force figment; there is the electric current, per se, and its rate of flow, which requires for explanation an advance reference to the effects produced by currents; there is the electric induction of magnetism, with its proportionality to ampere-turns, to magnetic conductance, etc.; then there is the magnetic induction of electric potential, involving rate of flux-change and distribution of flux; and lastly, after the relations between potential, current and resistance have been stated, self-induction and the commercial generation and transformation of alternating currents can be taken up.

Mr. Raymond goes through these preliminaries in the brief space of 19 small pages, reaching the subject of Self-induction at the top of p. 20. He accomplishes in this space even more than is ordinarily attempted, since he includes the beginnings of trigonometry, at least as far as concerns the elementary explanation of sines, the sine-curve and effective values. Perhaps many professional teachers of electrical engineering will feel that so compact a presentation of magneto-electric principles must put exorbitant demands on the intelligence and concentration of the student.

Again, proceeding from this point, the author covers the subjects of self-induction, capacity, impedance, saturation, hysteresis, eddy-currents, power-factor and some related matters, in the next 25 pages. This also is a feat in the way of compactness! Even a hint of the properties of resonant electric circuits is given in these pages.

However much such brevity of presentation may be condemned as being insufficient from a pedagogical standpoint, it must be conceded that there is a large practical value in this very brevity. Though the text may for many purposes be dead, from fatal excess of compactness, yet it forms a true skeleton of the elements that make up the subject of alternating-current working. Only those phenomena and relations are stated which are actually necessary to a comprehension of the complex problems of practice. The whole chain of phenomena is brought within such a small space that from each point the reader can overlook the entire chain from its beginning and can get a connected understanding of the sequence of phenomena. There are very many text-books, on this and other subjects, of which the same thing cannot be said; in their mazes of excursion into details the student is lost before he has progressed half-way, and can see neither the beginning whence he came nor the end toward which he is proceeding.

But in order that this value be realized from extremely compact presentation, two things are required. The first is that each phenomenon and relation be explained far enough to lead on to the next; else the book becomes a mere synopsis lacking cohesion. It is not essential that all statements be deduced theoretically: the effective value of a sine current need not be derived by integration, but may be simply stated as a fact; but each statement must be *clear* to the reader. The author (we speak now only of the first part of the book, above described) meets this requirement moderately well, though some points, as, for instance, the explanation of flux-calculation or the explanation of the 90° lag of self-induction voltage, would profit by revision.

The second requirement is that abundant references to other works be given, to enable the student to follow up more in detail any or all of the phenomena here treated. This is especially important in those places where theoretical derivations have been omitted for the sake of brevity or simplicity. In this requirement the author fails, for he gives no references whatever.

The second chapter of Mr. Raymond's book, wherein he explains by several examples the method of combining alternating currents and voltages in "vector diagrams," is open to the same comments as the first. The reader is required to take much on faith, although he may not always be aware of it. From a practical viewpoint it appears unfortunate that the author does not emphasize the "volts required" and "volts consumed" opposition; for any uncertainty in this matter leads to direct error in drawing conclusions from the vector diagram of any circuit.

The preparatory matter given in these two chapters characterizes the book. The remainder, constituting the bulk of the volume, must stand or fall by the first 75 pages. It is effective only in so far as the previous explanation of inductance, of vector diagrams, etc., etc., has taken root. Considered by itself, the second part treats its various subjects in a practical style and with an approach to the brevity of the first part. The separate subjects are: The Transformer, its action, design, testing and method of connection; Distribution Systems, discussed in a few pages which are supplementary to some matter on transmission systems given in Part I; Alternating-current Motors, including the induction motor and (briefly) the repulsion motor; and Alternating-current Generators and Synchronous Motors. The methods of testing transformers and generators are described in much detail, though only one method is given for each machine. References to other works, as was previously suggested, would be particularly valuable in this part of the volume.

Throughout the book the diagram method of analysis is used hand in hand with algebraic expression. We are inclined to believe that the class of readers who will profit most by the book will prefer to use the diagram method exclusively. A little more care and precision in explaining the individual diagrams would, therefore, be worth while, even if a little more space were required thereby. It is further to be noted that no calculus appears in the book, a thoroughly good feature.

The make-up of the book is substantial and the type work is clear and large. The mechanical work on the illustrations is quite poor.

*Consulting Electrical Engineer; Professor of Physics and Electrical Engineering, Polytechnic Institute, Brooklyn, N. Y.

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NATIONAL MUNICIPAL LEAGUE.—Proceedings of the Chicago Conference for Good City Government and the Tenth Annual Meeting of the National Municipal League, Held April 27 to 29, 1904. Clinton Rogers Woodruff, Editor. Philadelphia: National Municipal League, North American Building. Cloth; 6 x 9 ins.; pp. 416.

Among the many organizations devoted to municipal affairs this one is unique in that its membership is not drawn from the office-holding class. There is nothing to prevent holders of municipal or other offices from becoming members, or more correctly, associate members, but the interest in good government, rather than official participation in government good or bad, is the primary condition of membership.

Nine volumes, reporting ten annual meetings, have now been published by the League, each full of papers, reports and discussions of vital interest to those striving to better municipal administration. Each volume contains reviews of some one or more phases of municipal government in a number of cities and the later volumes, at least, also contain a review of general municipal progress for the year, prepared by the secretary.

The League engages in constructive as well as destructive criticism. It frames what may fitly be termed practical ideals of municipal advance. The first of these practical ideals was the "Municipal Program," which has already been made the basis of city charters and city charter legislation in a number of States of the Union. A paper on certain phases of the program, by Mr. Delos F. Wilcox, appears in the volume before us. At present several committees of the League are engaged in constructive work. The oldest of these is the one on Uniform Municipal Accounting and Statistics, which has already presented several preliminary reports and has one, accompanied by several papers, in the present volume. The schedules prepared by this committee have been adopted or adapted by a number of cities and have been made the basis for municipal statistics by two State

departments and by the U. S. Bureau of the Census. Other committees of the League are now working on instruction in municipal government in educational institutions, on nomination reform and on municipal taxation. Papers on each of these subjects appear in the present volume.

The Erie Canal.

THE GREAT AMERICAN CANALS.—Vol. II. The Erie Canal. Being Vol. 14 of Historic Highways of America. By Archer Butler Hulbert. Cleveland, O.: The Arthur H. Clark Co. Cloth; 6 x 8 ins.; pp. 234; five folding and other plates. Complete in 16 volumes. In sets only. $39 net.

On the eve of letting the first contracts for the $101,000,000 improvements to the Erie Canal, the publication of a historical sketch of the canal from its inception is timely. The present volume is not as interesting as its immediate predecessor in this series, dealing with the Chesapeake & Ohio and the Pennsylvania canals (Supplement for Oct. 13, 1904). This is due to causes both within and beyond the control of the author. The histories of the other canals comprised a long series of struggles with nature and human nature, resulting in periods of hope and despair. In the end the canals succumbed to the railways. The Erie Canal, great as were the odds with which its promoters and builders contended, has more nearly met the anticipations of its friends from the start, has had successive enlargements and is now, as has been mentioned, about to enter upon a new period of development. To some minds, it is true, these differences will cause the interest in the story of the Erie Canal to rank above that in the Chesapeake & Ohio and in the Pennsylvania Canal, but certainly, at least as described in these volumes, the Erie Canal is less picturesque than the other two. The points just raised relate to features largely beyond the control of the author. Wholly within his control was the industry and zeal bestowed upon the two volumes. The volume devoted to the Erie Canal appears to suffer in this respect. Perhaps our feeling is in part due to a sense of disappointment over the author's failure to bring out the fact that the Erie Canal was for many years a training school for civil engineers, the influence of which is still felt. With the enlargements soon to be put under contract this important function will continue, but it will be of far less moment than formerly because of the excellent schools which now exist for the elementary training of the engineer; schools scarcely dreamed of in the early days of the Erie Canal.

In the first of the two volumes devoted to canals the effect of the railways which followed so closely the tow-paths, in both time and location, was discussed. In the volume before us the vital question of canal vs. railway, which has so stirred the people of New York State, is touched upon scantily, if at all.

The present volume opens with an account of the early improvements of the Mohawk River. This is followed by early schemes for a canal, Clinton's memorial, planning and building the canal, its local influence, the original canal fund and the various enlargements.

Finally, our criticisms should be considered in the light of the fact that this volume is a part of an extended series on the historical aspects of our various great American highways. To devote a whole volume to the Erie Canal is in itself an evidence of the author's conception of the relative importance of that particular national highway.

LEAFLETS ON HYGIENE AND SANITATION.—Series A: On Dirt and Disease. No. 1. Why Dirt is Dangerous. No. 2. Why Dirty Milk is Dangerous. By Prof. Wm. T. Sedgwick, of the Massachusetts Institute of Technology. Reprinted from the Journal of the Massachusetts Association of Boards of Health for May and August, 1904. Boston: Massachusetts Institute of Technology. Paper; 6 x 9 ins.; pp. 7 (each). Single copies will be sent on receipt of stamped and addressed envelopes; Less than 50 copies at 2 cts. each; 50 or more copies at 1 ct. each; larger quantities by special arrangements.

These leaflets are being prepared at the request of an unknown giver of a fund for sanitary research at the Institute and are designed to bring home to the people some of the results and possibilities of modern sanitary progress. The many readers who are familiar with the researches and writings of Professor Sedgwick need not be told that the leaflets are models of clear, simple and interesting expression of vital sanitary truths. To those unfamiliar with this writer we take pleasure in introducing him. Since the leaflets may be secured so easily and cheaply we will refer our readers to the originals for further information as to their contents.

UNTECHNICAL ADDRESSES ON TECHNICAL SUBJECTS.—By James Douglas, LL.D. New York: John Wiley & Sons. London: Chapman & Hall. Cloth; 5 x 7½ ins.; pp. 84. $1.

The three addresses that are contained in this little volume are as follows: "The Characteristics and Conditions of the Technical Progress of the Nineteenth Century," a Presidential address at the California meeting (Sept., 1899) of the American Institute of Mining Engineers; "The Development of American Mining and Metallurgy," and "The Equipments of a Training School," an address delivered (May, 1901) before the School of Mines and Metallurgy, of the University of Missouri; "Wastes in Mining and Metallurgy," an address given (April, 1904) before the Michigan College of Mines.

In the first-named address the author presents a powerful arraignment of the practice of secrecy in metallurgical establishments. A few quotations will indicate the general tenor of this address:

> As time goes on, and a generous dissemination of personal knowledge becomes the rule and not the exception, it will be discovered that, after all, success in manufacturing will depend as much on the personal energy and skill with which the knowledge is applied as on the possession of the knowledge itself.
>
> The man of genius, therefore, need not grudge the communication of his facts to his less progressive competitor, provided he learns, in exchange, what few facts his slower neighbor may have picked up by the way.

The author combats the prevailing foreign opinion that American progress has been mainly due to the possession of vast natural resources. In closing his first address he says:

> The conclusion and lesson I would rightly or wrongly draw from the preceding general survey is, that the industrial standard of a nation of the twentieth century is likely to be determined more by its capacity for progress than by its mere possession of crude natural resources.

In the second address the author ascribes the wonderful achievements of American metallurgists to the invention and development of mechanical appliances rather than to superior chemical knowledge. He says:

> The Yankee, after all, has been the creative genius of our continent. The original Yankee was a mechanic and turned his talent to making wooden nutmegs and wooden clocks. The result of this Yankee infusion is that, as a people, we are more given to devising mechanical contrivances than to synthetical chemistry.

These three addresses are of a kind to awaken thought upon the general principles that underlie success in metallurgical, mining and other fields—in a word, they will broaden the view, particularly of men whose training in details has had a narrowing tendency. They can be heartily commended as being interesting, instructive and educative in a broad sense of the term.

TRANSVERSAL DAMPFTURBINEN.—By A. Patschke. Mulheim a. d. Ruhr. Stiff Paper; 6 x 9 ins.; pp. 73; 16 plates. Mulheim a. d. Ruhr, Germany: H. Wilhelmi Machine Works. 2½ marks, or $1.

This pamphlet is published in the interest of a new style of steam-turbine invented by the author. This consists of a hollow cylindrical rotating element arranged in a cylindrical casing. The outside surface of the rotating element has radial drill-holes arranged over its entire surface; these holes are the buckets and exhaust inwardly through a small hole drilled through the bottom of each hole. The steam is led into the casing tangentially by a nozzle and thence follows a helical passage formed in the inside surface of the casing. As this passage proceeds from the steam nozzle, it constantly decreases in cross-section, until its final disappearance. Usually the inventor arranges two such helical passages, following a right and a left-hand helix, from a single nozzle near the middle of the length of the wheel; each of the two passages ends before it gets to the end of the wheel. The action of this turbine is explained in the pamphlet as follows: A thin layer of the stream of steam enters each radial bucket-hole at a small angle to the tangent; it then strikes the far side of the hole, is reflected back to the near side, thence back to the far side and so on for a number of reflections until finally it passes in a graceful curve through the small hole in the bottom to the exhaust passage. At each reflection of the thin stream at the forward surface of the bucket the wheel takes up energy from the steam, while at each reflection at the rearward surface it loses energy to the steam, but not as much as it gained at the reflection just preceding, so the inventor claims. He also claims that with a sufficient radial depth of hole the number of reflections may be made large enough to abstract *all* energy from the steam; he notes that imperfect elasticity causes the relative velocity after each reflection to be less than the relative velocity before reflection, the difference representing energy imparted to the wheel. This idea is "proved" by an array of algebraic equations, to which the author gives the pleasing name "theory of transversal vibrations of a stream of steam." After these characteristic "transversal vibrations" he calls his machine a "transversal steam-turbine." The whole is of rather humorous effect.

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Table of Contents on Application to

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BULLETINS U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 6 x 9 ins.

No 232: A Gazetteer of Virginia. By Henry Gannett. Pp. 159.

No. 233: A Gazetteer of West Virginia. Pp. 164.

No. 241: Experiments on Schistosity and Slaty Cleavage. By George F. Becker. Pp. 34; 7 plates, including 33 figures.

Each of the gazetteers opens with a brief general description of the State to which it is devoted and continues with an alphabetical descriptive list of the cities, villages, mountains and streams of the State.

Mr. Becker's monograph on "Schistosity and Slaty Cleavage" is worthy of special note, for it contains the results of a large number of experiments made by him to determine the cause of slaty cleavage.

Mr. Becker's experiments overturn the commonly accepted theory of Sharpe, namely, that cleavage is developed in planes perpendicular to the pressure. Mr. Becker has made what he calls a "scission engine" for compressing and at the same time producing a shearing stress in clay, ceresin and the like. By the tests made with this engine he has demonstrated the truth of his theory of slaty cleavage which was first announced by him in 1893. According to Becker's theory, "cleavage is due to a weakening of cohesion along planes of maximum tangential strain (or maximum sliding)."

INFORME BI-ANUAL SANITARIO Y DEMOGRAFICO DE LA REPUBLICA DE CUBA.—(Report of the Superior Board of Health of the Island of Cuba for the Years 1902 and 1903). Carlos J. Finlay, Chief Sanitary Officer for the Island of Cuba. Paper; 10 x 12 ins.; pp. 163; many tables. Havana, Cuba: Pub. Doc.

Two pages of introductory text, printed in Spanish and repeated in English, are followed by tables of vital statistics for the greater part of the island of Cuba. For three years "not a single case of yellow fever has developed" on the island, there has been scarcely any smallpox, and during the period malaria has dropped to a comparatively low figure.

Additional Water Supply for New York.

REPORT OF THE COMMISSION ON ADDITIONAL WATER SUPPLY FOR THE CITY OF NEW YORK.—Made November 30, 1903. Commission: William H. Ma[r]r, Chairman; Rudolph Hering, John R. Freeman. New York: Commissioner of Water Supply, Gas and Electricity. Cloth; 7 × 10 ins.; pp. 980; tables, folding maps and diagrams and figures in the text.

Appendix VI.—Chemistry and Biology. George C. Whipple, Department Engineer. Reprinted from the Forecasting Report. Cloth; pp. 299 to 616; tables, folding maps and figures in the text.

It is doubtful whether there was ever before made so comprehensive an investigation and report on a water supply for a city. Three of the foremost engineers of the country, assisted by a large staff, some of whom were also well-known specialists, devoted a year to the study of the many and various problems involved in the future water supply of the American metropolis. The one problem which embraced all the others was how to provide water enough for a population already numbering more than 3,500,000, scattered over an area of 327 sq. miles. With an estimated increase to 6,320,000 by 1925, and assuming a consumption of 150 gallons per capita at that time, a total of 948,000,000 gallons per day would be required. To bring the present and potential capacity of the existing works up to that figure a supply of 500,000,000 U. S. gallons a day must be added. This, the engineer-commission finally proposed, would be brought in by gravity, from both sides of the Hudson River, through a single aqueduct 18½ ft. in vertical diameter having a maximum width of 19 ft. Both the new supply and the present supply from the Croton would be filtered. The total estimated cost of construction proposed between the date of the report (late in 1903) and 1925 was $111,500,000.

A preliminary report of the engineer-commission was printed in Engineering News of Oct 1, 1903, filling more than three pages of that issue. An abstract of the final report (not including the appendixes mentioned further on) appeared in our issue of Dec. 24, 1903. A map accompanied each of the articles named.

Since the volume before us comprises nearly a thousand pages, and we have already presented the main report practically in full, we will confine our further remarks to an outline of the contents of the ten appendixes. The first of these was prepared by Mr. E. G. Hopson, and consisted of a description and estimates of the proposed collecting works on the east side of the Hudson River, the aqueducts therefrom to a point near the city and certain aqueducts on the west side of the Hudson. A table in this appendix shows the cost per 1,000,000 gallons storage capacity of a number of large reservoirs, and other tables of note give data on the capacity cost of large steel conduits.

Investigations of storage reservoirs west of the Hudson, in the Catskills, are described by Mr. Walter H. Sears in Appendix II. The third appendix, on proposed aqueduct sections, by Mr. Hopson, is brief, but is accompanied by many line drawings. Messrs. Hopson and Sears joined in a discussion of rainfall and run-off, forming Appendix IV. "Filtration," by Mr. Wm. B. Fuller, is a notable study. A two-page table, in small type, gives in detail the estimates for a 50,000,000 and a 450,000,000-gallon slow sand filtration plant and accessories. This is followed by a "preliminary draft" of specifications for the proposed filter plant.

Another valuable contribution to the general literature of water supplies, and one which will also be widely useful, is "Chemistry and Biology" (Appendix VI.), by Mr. George C. Whipple. Reprinted, as this has been for Mr. Whipple, this makes a volume of more than 300 pages. The author discusses the quality of the present water supplies of New York City and therewith presents a valuable collection of typhoid fever statistics for New York and other cities. He gives the results of stream and ground water supply investigations, during which thousands of analyses were made. He also goes into the question of soil physics, including soil texture, sand analyses, percolation and capillarity. Studies of the Hudson River, in relation to the filter plant at one time seriously considered for water from this stream, included tidal influences and saltness of the lower river water.

Still another unique series of investigations is reported in Appendix VII.: "Long Island Sources," by Mr. Walter E. Spear. The underground water resources of Long Island have always been of far more than local interest.

Mr. Spear writes of both surface and underground supplies. He takes up rainfall, evaporation, stream flow, percolation, variations in the levels and depths of the ground water and suggested methods of securing an additional supply from the ground. This appendix contains sketches of rain gages, evaporometers, rigs for boring test wells, stream gages, besides many other illustrations, both line and half-tone.

The department of pumping, with Mr. Will J. Sando in charge, did some valuable work in showing large possible economies in operating existing pumping stations, made designs for immense new pumping stations in connection with the Hudson River filtration scheme, and gathered some figures on the cost of operating existing large pumping plants.

Water-waste studies, largely made with the Cole-Flad pitometer, are the subject of Appendix IX., which has been separately printed and was briefly noted in this Supplement for Aug. 18, 1904. The final appendix gives the names and titles of the departmental and the principal assistant engineers, chemists and bacteriologists. A summary shows that during a portion of 1903 the commission had a force of exactly 200 in its employ, including 28 engineers, 25 draftsmen and computers, 44 instrumentmen, rodmen and chainmen, and 30 sample collectors and gage readers.

INTERBOROUGH RAPID TRANSIT.—The New York Subway: Its Construction and Equipment. New York: Interborough Rapid Transit Co. Cloth; 10 × 13½ ins.; pp. 154; illustrated.

This volume has been published by the Interborough Rapid Transit Co. as a souvenir of the completion and opening of the New York rapid transit underground railway. It contains a brief history of the development of the project for an underground passenger railway in New York City, followed by descriptions of the subway and elevated structures and of the methods and machinery employed in constructing them and descriptions of the power plant, rolling stock, signal system, shops and general equipment. As might be expected from the purpose of the volume, the treatment is popular rather than technical, but on the whole it gives a very fair idea of the task of construction and of the method of accomplishing it. The book is illustrated by many handsome half-tone engravings from photographs and by maps of the line and line drawings of some of the general structural details.

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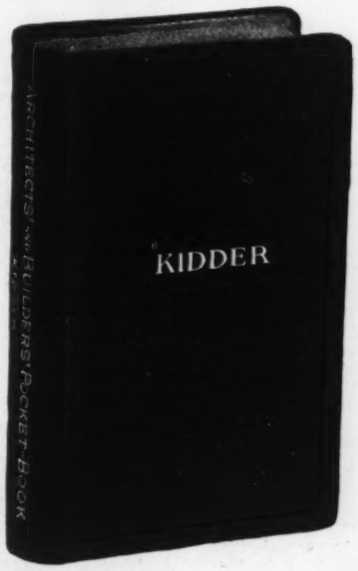

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Royal Laboratory for Testing Material at the Berlin Technical College.

DAS KOENIGLICHE MATERIALPRUEFUNGSAMT DER TECHNISCHEN HOCHSCHULE BERLIN.—Inauguration Memorial, compiled by Prof. A. Martens, Director, and M. Guth, Constructing Engineer. Berlin: Julius Springer. Paper; 9½ × 12¼ ins.; pp. 380; 5 folding plates and 359 figures in the text. 10 marks or $4.

It seems to the engineer an appropriate fact that the Berlin government testing laboratory, the largest institution of its kind in the world, should trace its origin back to the endurance tests begun by Wöhler in 1863. Wöhler was then master mechanic of the railway repair shops at Frankfurt-on-the-Oder. In 1870 the Prussian government ordered these experiments to be continued at the Trade School at Berlin, which was then under the direction of Professor Reuleaux; by 1876 the laboratory here had come to call itself Testing Laboratory for the Strength of Steel and Iron; public testing had been established here in 1875. In 1879 this laboratory, with a chemical testing laboratory established two years before, was placed under a separate governmental board, and the laboratory came into existence as a public testing laboratory on a broad basis. Since then the institution has grown in scope and value of work, and in size, until last year the new home of the Laboratory, a magnificent large plant at Gross-Lichterfelde-West, near Berlin, was occupied. The first director of the Laboratory, Professor Spangenberg, died in 1881, and was followed by Dr. Böhme, who remained in office for three years. In 1884 Prof. A. Martens took the office, and has remained in charge until the present time.

We extract this summary from the opening chapter of the inauguration memorial prepared at the opening of the new home of the laboratory, because the existence and successful working of this notable institution give rise to regretful reflections on the absence of such a laboratory in this country. The work done by the laboratory is, no doubt, known to many in part; it covers all branches of mechanical and chemical testing, from steel down to oil and paper testing. Of its value we need cite only one item of proof: In 1884 a special division for paper-testing was established in this laboratory. At present, so Professor Martens writes, "Paper-testing has been securely developed, mainly through the work of this laboratory, and has become perhaps the *best-developed branch of material-testing.*" In connection with this statement it must be remembered that Germany to-day leads the world in excellence of paper industries.

The present elaborate memorial presents an interesting survey of the work of the laboratory. The greater part of the volume, however, is occupied by a very detailed description of the construction and equipment of the new laboratory. Drawings and photographic views in profusion illustrate the text. A 500,000-kg. (550-ton) horizontal testing machine, built in 1891, is the largest single item of the mechanical testing machinery.

British Scaffolding.

SCAFFOLDING.—A Treatise on the Design and Erection of Scaffolds, Gantries and Stagings, with an Account of the Appliances Used in Connection therewith. By A. G. H. Thatcher, Building Surveyor. London: B. T. Batsford. Cloth; 5½ × 8 ins.; pp. 185; 6 plates and 146 figures in the text. $2.

A cursory glance through the pages of this book indicates that the English practice of scaffolding, as illustrated, differs decidedly from American practice. A reading of the text serves to confirm the first impression of the book. Although ropes are occasionally used in this country for lashing together scaffolding timbers, the practice is the exception rather than the rule; whereas in England, judging from the illustrations in this book, the use of bolts and spikes for fastenings is exceptional. Most of the scaffoldings shown are made of poles.

Taking the subject matter by chapters we find the first chapter (pp. 29) devoted to scaffolding in general. Derrick stagings, consisting of three or four high timber towers supporting a platform, are illustrated and briefly described. Such stagings are rarely seen in this country; for in erecting brick and masonry buildings the material is usually lifted to the floors by hoisting engines located on the ground and operating small elevators or "lifts." Light breast derricks, supported by the flooring, serve to place the heavy pieces, and these breast derricks are raised from floor to floor as the work progresses. On the other hand, in erecting the tall steel-frame buildings so common in this country, the derricks are supported by the steel framework. Incidentally it may be remarked that the methods of erecting steel-frame buildings have never been described in any book, the reason for this being the small demand for such a book in view of the fact that a few large firms handle nearly all this class of work.

Pole-scaffolding is illustrated in some detail in this first chapter, but stagings are dismissed with a few words, as they are "a form of scaffolding rarely seen since the introduction of the Scotch derrick system."

The second chapter (pp. 19) is devoted to scaffolds for special purposes and contains several good hints. A needle scaffold and scaffolds for chimneys and towers form the subject matter of the best part of this chapter.

The third chapter (pp. 12) on shoring and underpinning is very unsatisfactory, particularly the part on underpinning, upon which there are only two pages of text and one illustration.

Little need be said about the fourth chapter, which treats of timber, since little is said by the author on timber. The fifth chapter on cordage and knots contains four good plates showing the various types of knots commonly used.

The longest chapter in the book is the sixth, on scaffolding accessories and their use, to which 24 pages are devoted. Pictures of wheelbarrows, hods, trucks, rollers, levers and other catalog matter fill many of the pages and add nothing to the value of the book. The succeeding chapter, on the transport of material, is quite as valueless as its predecessor.

So far as the subject of scaffolding proper is concerned less than 80 pages are given, if we except the chapter on English laws relating to scaffolding, and the two chapters on the stresses in scaffolds, which, by the way, treat solely of the resisting power of scaffolds and do not consider loading.

This is the only book on scaffolding which we remember of having seen. While wishing that it were better, and that it contained something more closely related to American practice, there is reason to be thankful for this much on the subject. Those having occasion to use lashed scaffolding will, of course, find most of value in the book, and an examination of it may lead more Americans to try the system of scaffolding which is so commonly seen in Great Britain.

MECHANICAL APPLIANCES.—Mechanical Movements and Novelties of Construction. By Gardner D. Hiscox, M. E., Author of "Gas and Gasoline Engines," "Compressed Air," etc. New York: The Norman W. Henly Publishing Co. Cloth; 6 × 9½ ins.; pp. 396; many illustrations. $3.

This book is called a second volume of the author's "Mechanical Movements," which was first published in 1899 and has passed through ten editions. It consists like that book of a miscellaneous collection of examples of machinery and devices covering a very wide range, some of them modern, some obsolete and many of interest merely as curiosities. For example, Section XI. of the book is devoted to Navigation, Vessels, Marine Appliances, etc., and of the 16 pages which it contains 5 pages are taken up with "curious boats" and outlines of the models of the America cup racing yachts of the past twenty years.

Section XXIII. is devoted to perpetual motion and no less than 56 devices are illustrated and described by which inventors have sought to achieve the impossible. We note with interest, however, that the author himself appears to be a little heterodox on the perpetual motion idea, for he says (p. 364): "It has long been and so remains to this day an unsettled question whether perpetual motion is, or is not, possible." If by "perpetual motion" the author means a machine which will keep itself in motion without the application of external energy in any form, which is the common meaning of the term, he should proceed at once to lift himself by his own bootstraps until he has tugged long enough to convince himself that perpetual motion is no longer an unsettled question.

The total number of devices listed in this book is 970 and inasmuch as they range over the whole field of the mechanic arts, from a screw-driver to a floating breakwater, it will be readily understood that the work makes no pretension to completeness. From a cursory examination we should judge that not over half the devices shown are in actual commercial use. The book will interest the amateur more than the engineer.

PROVINCIAL BOARD OF HEALTH FOR ONTARIO.—Report for 1903. Toronto, Ont.: Chas. A. Hodgetts, M. D., Secretary. Paper; 7 × 10 ins.; pp. 105; tables.

Two general papers by Dr. P. H. Bryce, until recently secretary of the board, may be mentioned: "The Evolution of Public Health as a Department of Municipal Government" and "Contagious Diseases in Their Economic Relationships." The first of these includes a historical review of municipal development in both Great Britain and Canada, with some notes on the United States and its influence on Canada. The volume contains a few brief committee reports on water supply and sewerage propositions in different municipalities.

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Notable Air Brake Tests.

AIR BRAKE TESTS.—Compiled and Published by the Westinghouse Air Brake Co. Leather; 4¼ × 7 ins.; pp. 23; 130 illustrations.

The title page to this book states that it was published in connection with the exhibit of braking appliances at the Louisiana Purchase Exposition. It is far above the standard of ordinary exposition literature and is, in fact, an authoritative and complete technical treatise on the subject named.

The development of the air brake has been, we hardly need say, a most important feature in American railroading, and it is the more noteworthy in that its introduction is comparatively recent. The Westinghouse straight air brake was brought out in 1869 and the Westinghouse automatic brake in 1872; but the use of these brakes was confined to passenger service. It was not until the close of 1887 that the present quick-action automatic freight brake was offered to the public and its extended use in railway freight service is only a matter of the last dozen years.

This book is a full record of the notable brake tests which have been carried out during the whole development of the air brake, beginning with the famous Galton-Westinghouse tests of 1878-79. The original report of these tests was given in a series of papers read before the Institution of Mechanical Engineers of Great Britain, and these papers are all reprinted here in full. These tests are particularly worth permanent record, because the data which they furnished for the first time placed the design of brakes on a sound scientific basis and also gave important information respecting the friction between unlubricated surfaces.

To our minds, however, the most valuable and interesting feature of the whole book is the full and authoritative record of the Burlington brake trials of 1886 and 1887. It is not too much to say that the railways of the United States owe a large debt to those officials of the Chicago, Burlington & Quincy Ry. and the Master Car Builders' Association, who planned and conducted what was probably the most remarkable competitive trial of railway appliances ever undertaken. In the volume before us a complete account of these Burlington brake tests is given and the different braking systems there tested are described and illustrated.

Large space is also given to the tests on the New York Central & Hudson River R. R., near Karner, N. Y., in 1892, which was the first occasion in which competitive tests were made of Westinghouse and New York air brakes. Among the more recent tests are those at Sang Hollow on the Pennsylvania R. R., tests on the Nashville, Chattanooga & St. Louis R. R. to determine whether it is advantageous to reverse a locomotive after applying driver brakes in making an emergency stop and tests at Absecon and Atsion on the Central R. R. of New Jersey.

The book ought to be included in every railway mechanical library making any pretension to completeness, and we trust that its publishers, who have shown such enterprise in the compilation and printing, will see that copies are distributed to the engineering school and society libraries throughout the country, where they will be permanently preserved.

REPORT ON DRAINAGE INVESTIGATIONS, 1903.—By C. G. Elliott, Assistant, in Charge of Drainage Investigations. Bulletin No. 147, Office of Experiment Stations. A. C. True, Director. Washington, D. C.: U. S. Department of Agriculture. Paper; 6 × 9 ins.; pp. 62; five plates and 12 figures in the text.

In a brief introduction to this report, Mr. Elwood Mead, Chief of Irrigation Investigations, points out that the area of land in the East requiring drainage is about equal to that in the West requiring irrigation. Drainage is also needed in the irrigated West. In fact, considerable areas of irrigated land have been abandoned because they have been made swampy by seepage waters.

Mr. Elliott presents plans and estimates for draining a large tract of land near Fresno, Cal., and gives the results of drainage investigations in three places in Washington and also in Wyoming and Iowa. He describes briefly an attempt to prevent hillside erosion in the South by means of drainage. The attempt appeared to be successful the first year after the drainage tiles were laid, but the rainfall was too light to give a fair test.

EXHIBIT OF THE U. S. BUREAU OF LABOR AT THE LOUISIANA PURCHASE EXPOSITION.—Bulletin of the Bureau of Labor, No. 54, September, 1904. Washington, D. C.: U. S. Department of Commerce and Labor. Paper; 6 × 9 ins.; pp. 969 to 1430; 266 illustrations, including both diagrams and half-tones.

It will be a revelation to many of those who see this large volume to learn the nature and extent of the investigations carried on by the Bureau of Labor. The workings of the Bureau are described by the Hon. Carroll D. Wright, Commissioner of Labor. Other labor bureaus in this country and also similar bureaus in foreign countries are described by Mr. G. W. W. Hanger, one of the associate editors of the Bulletin. Mr. Hanger also writes on strikes and lockouts in the United States; wages in the United States and Europe; cost of living and retail prices, and also wholesale prices, in the United States from 1890 to 1903. The same author contributes a section on the housing of working people in the United States by their employers. A portion of the volume of much interest, also by Mr. Hanger, deals with public baths in the United States and describes such institutions in 37 cities. These are under municipal ownership. In addition, five non-municipal baths are described. Other subjects treated at length are trade and technical education and labor legislation in the United States.

IMPROVEMENT, REPAIR AND MAINTENANCE OF PUBLIC HIGHWAYS.—Bulletin No. 7, Department of State Engineer and Surveyor of the State of New York. Albany, N. Y.: Pub. Doc. Paper; 6 × 9 ins.; pp. 124; illustrated.

This interesting bulletin contains valuable hints on the maintenance of earth, gravel and macadam roads. It also illustrates and describes in detail the method of making concrete-steel slabs for use with I-beams in building culverts and short-span highway bridges. The laws of the State of New York governing highway improvement are given, followed by tabulated data as to road mileage, population per mile, and money spent on road work in each town of each county in the state. A large folding chart in the back of the bulletin shows at a glance the acres per mile of road, the assessed valuation per mile and the cost of road maintenance per mile per year for each town in the state. The chart is worthy of study, and in years to come a continuance of this method of recording maintenance data will be exceedingly valuable.

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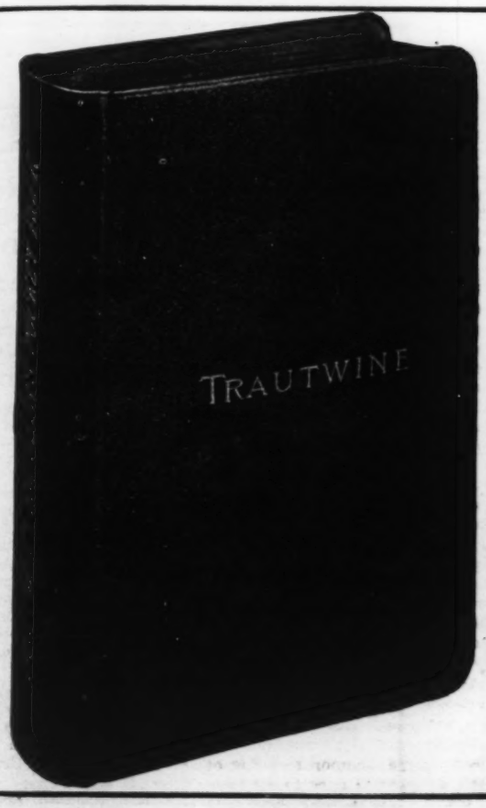

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Literary Magazines.

A study of the canal boatmen of France is found in the November "Century." The navigable waterways within the borders of France aggregate 8,000 miles in extent, and carried in 1902 32,000,000 tons of freight. The boats used on the canals vary in capacity from 320 tons for the largest to 60 tons for the small, old style boats. Many of these smaller boats are hauled by man power, and make no more than eight or ten miles a day. Another "Century" article describes the work of the "Welfare Manager" in a modern factory or store, whose duty it is to look after the provision for the health and comfort of the employees, and see that they work and live under conditions which will best conduct to their efficiency.

Conditions in the Russian Army are vividly described in the November "Scribner's" by Thos. F. Millard. He has the highest praise for the Russian private soldier, but criticises in severest terms the Russian officers for their habitual drinking and dissipation. Concerning the Siberian railway, which is such an essential factor in the conduct of the war, he states that while not up to the standard of the best American and European railways, it is well built and the rolling stock is better than that of the average railway of Europe. As to its ability to transport troops from European Russia to Siberia, he states that for the first five months of the war, up to July 10, the daily average of reinforcements arriving at Harbin was about 480. As the war progresses, however, and the stock of supplies in Manchuria is used up, a larger proportion of the railway's capacity will have to be given up to the transportation of food supplies. A limit will soon be reached, therefore, to the size of army which the Russians can maintain in Manchuria.

In the November "Atlantic" we find reminiscences of the commercial conditions of half a century ago in the story of the "Nightingale," one of the famous American clipper ships which in the early '50's carried a large share of the world's commerce. We may take space for only one incident of the career of the "Nightingale." She sailed on May 19, 1853, from New York City for Melbourne, Australia, going for the first time by a great circle course by advice of Lieut. Maury, then in charge of the Hydrographic Bureau at Washington. After 75 days' sailing, having made a distance of over 25,000 miles without once sighting land, the captain ordered his first officer to call him at 12 o'clock midnight, as he expected to make Cape Otway light, near Melbourne Harbor. "It did not vary three minutes from 12 o'clock," says the writer, "when the light was sighted." A more remarkable feat of accurate navigation was probably never chronicled.

In the "North American Review," Federal legislation with reference to railway safety appliances is discussed by Mr. John J. Esch of the House Committee on Interstate and Foreign Commerce. Mr. Esch recounts the history of the legislation of this sort already enacted, and urges additional legislation for the compulsory introduction of the block system, the prohibition of excessive working hours for trainmen, the use of steel frames for passenger and postal cars and an increase in the Government inspection force. In the same magazine, Hon. Hugh H. Lusk describes the Government telegraph system of Australia, and contrasts it with the American privately owned system to the large disadvantage of the latter.

In the "World's Work" the recent development of the submarine torpedo boat is described under the suggestive heading, "Will battleships be obsolete?" Two other well illustrated articles are devoted respectively to the American wheat crop and the cotton crop.

The matter of safety on railways, referred to above, is also discussed in this month's "Review of Reviews," the writer being Mr. Edward A. Mosely, of the Interstate Commerce Commission. It need hardly be said that Mr. Mosely treats his subject with entire knowledge. He advocates rapid extension of the block system and the use of the absolute block instead of permissive blocking on lines where the system is already in use. Where the block system cannot be afforded, he urges either radical reform of the train order system or else its entire abandonment and the substitution of the train staff or train tablet system. He also favors a third man in the cab of modern high-speed locomotives and a ticket collector to relieve the conductor on heavy high-speed trains, while, like Congressman Esch, he would rigidly limit the hours of work of trainman. The "Review of Reviews," has also three papers devoted to Canadian matters, that of most interest to our readers relating to the industrial and railway development of the Canadian Northwest.

Publications Received.

THE APPRECIATION OF SCULPTURE.—A Handbook. By Russell Sturgis, F. A. I. A., Author of "How to Judge Architecture," etc. New York: The Baker & Taylor Co. Cloth; 6½ × 10 ins.; pp. 235; 64 plates. $1.50, net.

THE ART OF WISE INVESTING.—A Series of Short Articles on Investment Values, Pointing Out the Essential Characteristics of Safe Investment Securities, with a Review of the Financial Pitfalls into Which Superficial Examination Inevitably Leads. New York: Moody Publishing Co. Cloth; 5 × 7 ins.; pp. 93.

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